PROCEEDINGS

OF THE

97th ANNUAL CONFERENCE

AMERICAN RAILWAY
BRIDGE & BUILDING
ASSOCIATION

1992

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Proceedings of the

Ninety-seventh Annual Conference

OF THE

American Railway
Bridge & Building
Association

Held at the

WESTIN HOTEL CHICAGO
Chicago, Illinois

September 21-23, 1992

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IN MEMORIAM

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1937-1938

H. M. WILSON
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PROCEEDINGS

Monday, September 21, 1992

Opening Joint Session

President Hill: As president of the Roadmasters and Maintenance of Way Association of America and on behalf of Mark Walbrun, president of the American Railway Bridge and Building Association, I declare the 104th annual conference of the Roadmasters and Maintenance of Way Association of America and the 97th annual conference of the American Railway Bridge and Building Association to be open and in joint session.

It is proper that we pause to ask for divine guidance and inspiration prior to commencing this conference. I would like to call upon Ray Snyder, a past president of the Roadmasters' Association, to give the invocation. Ray.

Mr. Snyder: Will you all please stand with me as I lead you in prayer. O Heavenly Father, we thank you for bringing us safely together for this conference and ask that you be with us as we share the information that will be presented here. Let our speakers feel your presence and draw strength from you as they make their presentations. Open the minds of those in attendance and stimulate their thoughts for implementation and future presentations. Help us to conduct our business in an atmosphere of love and sharing that portrays our lives, as you would have them. We ask for a safe trip home and your help in implementing what we learn here. We ask these things in Jesus' name. Amen.

President Hill: Thank you, Ray. We have a total of 487 registered as of 8:15 this morning plus 98 spouses, for a grand total of 585. That's a very encouraging number and I look forward to a very good attendance for this conference. At this time I would like to introduce the officers and directors of the Roadmasters and Maintenance of Way Association of America who are seated at the head table. As I introduce each person I ask that he stand and remain standing until all have been introduced. I also ask that you hold your applause until all introductions have been made. Beginning on my right, first vice president, Ken Welch, assistant vice president environmental, Union Pacific, Omaha, Nebraska; second vice president, Gene Schubel, assistant manager engineering, Burlington Northern, Springfield, Missouri; immediate past president, Jerry Cossel, chief engineer design and construction, Conrail, Philadelphia, Pennsylvania; treasurer, Keith Nordlund, project manager, CN Railway, Toronto, Ontario. Directors, Ray Brosseau, assistant supervisor maintenance of way, CP Rail, Toronto, Ontario; Johnny M. Johnson, director transit and rail, HDR Engineering, Irvine, California; Pete Murgas, engineer procedures and administration, Norfolk Southern, Atlanta, Georgia; Kendall Koff, project engineer, Southern Pacific, Springfield, Illinois; Jim Young, general manager maintenance of way, Southern Pacific, San Francisco, California; Ron Poulsen, director of construction, Union Pacific, Omaha, Nebraska; Wayne Russell, general director roadway maintenance and planning, Santa Fe Railway, Kansas City, Kansas; David Smoot, executive vice president, Indiana Hi-Rail, Connersville, Indiana; Darrell Cantrell, director maintenance, Burlington Northern, Overland Park, Kansas; Ken Johnson, assistant division engineer, CSX Transportation, Daphne, Alabama; David Kelly, vice president and chief engineer, Illinois Central, Chicago, Illinois; Herb Clark, director maintenance planning, Chicago and North Western Transportation Company, Chicago, Illinois. Herb is the spouse/guest activities chairman this year so you may not see too much of him today. You may now applaud. (Applause)

At this time I'll turn the podium over to Mark Walbrun, president of the B&B Association. Mark.

President Walbrun: Thank you, Steve. At this time I would like to introduce the officers and directors of the American Railway Bridge and Building Association who are seated at the head table. As I introduce each person I ask that he stand and remain standing until all have been introduced. Please hold your applause until the introductions have been completed. Beginning on my right, senior vice president, Paul Saletnik, engineer of buildings, Chicago and North Western Transportation Company, Chicago, Illinois; junior vice president, Don Steele, manager bridge construction, Union Pacific, Omaha, Nebraska; junior vice president, John Van Huis, chief engineer structures and production, Wisconsin Central, Fond du Lac, Wisconsin; immediate past present John Horney, senior director construction, Amtrak, Philadelphia, Pennsylvania; treasurer, Don Lewis, bridge construction engineer, Illinois Central, Chicago, Illinois. Directors, Doug DeBerg, assistant manager rail, Santa Fe Railway, Topeka, Kansas; Joe Lileikis, manager bridge maintenance, Union Pacific, Salt Lake City, Utah; John Creighton, B&B master, CP Rail, Toronto, Ontario; Johnny Bradley, assistant division engineer bridges, Norfolk Southern, Knoxville, Tennessee; Bob Carter, general B&B supervisor, Burlington Northern, Springfield, Missouri; Carl Young, project engineer, Conrail, Carlton, Michigan; and Dave Franz, bridge engineer, Kansas City Southern, Kansas City, Missouri. This is the Board of Directors of the Bridge and Building Association. (Applause)

At this time I would like to turn the podium over to Mike Franke, vice president of AREA, as Bill Glavin, the president of AREA, is unable to be with us today.

Greetings From AREA and REMSA

Mr. Franke: Thank you, President Walbrun. On behalf of President Bill Glavin of the AREA and the entire membership, I am pleased to extend our greetings and to wish both the Roadmasters and B&B associations a very successful and productive 1992 conference.

The rail industry continues to suffer from intense competition, both in market share and unit revenue and also, very recently, from new regulatory pressure. Our ability to prosper in this climate requires that we provide consistent, reliable, on-time transportation and, yet, at a profit. Our maintenance personnel's role is to maximize asset utilization and promote productivity enhancement while continuing to focus on safety, innovation and quality.

Sharing knowledge with each other at conferences such as this is an important ingredient in achieving these goals. The importance of the supplier participation in this effort such as our long and mutually beneficial relationship with REMSA also should not be underestimated.

I would like to take this opportunity to extend an invitation to everyone to attend the upcoming AREA fall technical conference scheduled for November 11-13 in Mexico. This conference will provide an excellent opportunity for dialogue on railway conditions and practices in our two countries, especially important in view of the expected North American Free Trade Agreement.

Again, we thank you for allowing the AREA to participate in the opening of your conference and a warm welcome to all. Thank you. (Applause)

President Hill: Thank you, Mr. Franke. Now I would like to introduce Mr. Josef Neuhofer, president of the Railway Engineering Maintenance Suppliers Association. Joe.

Mr. Neuhofer: Thank you. Presidents Hill, Walbrun, distinguished guests, ladies and gentlemen. On behalf of REMSA it gives me great pleasure to extend you greetings and best wishes for a most informative and successful meeting. While the main objective of REMSA is to make meetings such as this as enjoyable as possible, it is my pleasure to invite you to partake in all the events that we sponsor. The morning breakfast bar will be open each morning at 7:30 a.m. in the Cotillion Room. The traditional Tuesday evening reception will be held in the Wellington Ballroom and will begin at 6:15 p.m. Additionally, I call to your attention that a number of our members have individual hospitality rooms and suites to which you all are invited. I want you to know that much of the membership of REMSA appreciates the opportunity to meet with you on occasions like this. It affords us the opportunity in a much less controlled, more relaxed environment to discuss your needs in the railroad industry and at the same time provides us with the opportunity to inform you of the equipment and services we have available.

Those of us in the supply industry are not so naive as to not realize that the success of our respective businesses depends upon the success of the railroads. Not only do we strive to furnish you with the best possible tools available with which to do your job but we also strive to convince the public that railroads are the viable, economic and efficient system for transporting goods and people.

REMSA was pleased to join with the railroad industry last year in the legislative battle to restrain truckers extension of long combination vehicles. With the adoption of the North American Free Trade Agreement this will be a continuing problem. We pledge to you today that the members of REMSA will continue to vigorously support your opposition.

We have recently joined with RPI, the National Railroad Construction and Maintenance Association, the Railway Systems Supply, Inc., and the Railway Supply Association in the formation of the new rail, supply and service coalition to support positions beneficial to the railroad industry.

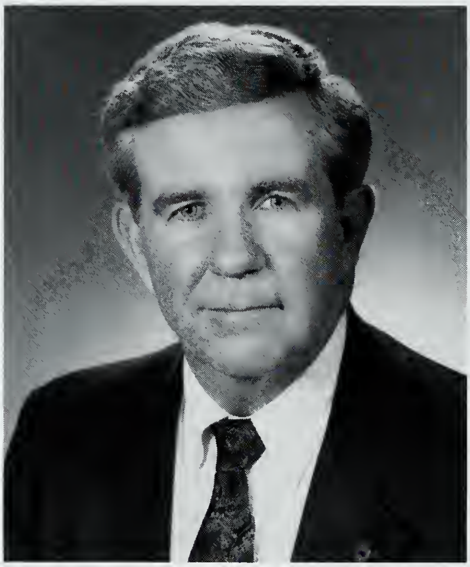
I cannot conclude without reminding you that REMSA's exhibition will be held in conjunction with your meeting next September in Denver. We look forward to seeing you there.

Also, I would like to remind you that tomorrow night's invitation to the reception includes your spouse or companion. We suggest that you stop at the ticket table outside to pick up your complimentary invitation.

I thank you again for the opportunity to be here with you today. (Applause)

President Walbrun: Thank you, Joe. At this time I'm happy to introduce Mr. Dennis Sullivan, executive vice president and chief operating officer of Amtrak. Mr. Sullivan received a degree in civil engineering at the University of Massachusetts in 1964 and completed the advanced management program of the Harvard Business School in 1984. Mr. Sullivan began his railroad career in 1964 with the New York Central Railroad and the Penn Central Transportation Company, holding several positions in the engineering department in New York and Pennsylvania. In 1973 he took a position with Amtrak as assistant engineer and held various engineering positions until 1981 when he was appointed assistant vice president engineering. In 1988 he assumed his present position of executive vice president and chief operating officer for Amtrak. Please join me in welcoming Mr. Dennis Sullivan. (Applause)

KEYNOTE ADDRESS



Dennis F. Sullivan

Executive Vice President
National Railroad Passenger Corporation

Thank you, Mark. Members of the two Associations' boards, ladies and gentlemen, it is indeed a pleasure and an honor for me to address this group today. As a member of the Roadmasters since 1974 and the AREA for over 20 years, I have gained a valuable insight into a very important segment of the railroad industry which is the spirit of volunteerism of these organizations that has helped the railroad industry save many dollars over the years in their R&D efforts and I would like to recognize that here today. I would also like to thank the suppliers who support these associations through meetings like this and through the equipment shows. This allows you, the members of the various organizations, to come and see the innovation that has taken place in the railroad industry. It is these types of innovations and advances that help the railroad industry, whether it be passenger or freight, remain competitive. When I joined Amtrak in 1973 the passenger business was about ready for extinction in the United States. Twenty years later we are seeing the beginnings of a revolution of rail passenger service in this country and as we approach the 21st century I believe that rail passenger service will continue to grow and expand in many areas. Whether it be in inter-city service, high speed rail, commuter rail, light rail or maglev, many technologies are beginning to come forward both here and abroad, and I believe we will see a continued expansion of these technologies here in this country.

I would also like to say that the industry is currently reviewing the value of many of the organizations which support it. As a member of the OT Committee of the AAR I have heard much of the debate over values of organizations such as the Roadmasters, B&B, AREA and so on and I want to just publicly state my support for these organizations. As I said, I have been a member for over 20 years of two of these organizations. I recognize the value that these organizations provide to the railroad industry in helping it remain vibrant and competitive and I can assure you that you will have a strong voice in support of these organizations from me as the debate and review go forward. I am confident that once all is said about the value of these organizations that you will remain an important segment of the railroad industry.

Introduction

From its humble beginnings in 1971 with $40 million of government funds and a vast array of worn out passenger cars and locomotives of every color and type possible, Amtrak has matured into a billion dollar enterprise. As the operator and marketer of intercity rail services, Amtrak provides quality transportation services to over 500 destinations in 45 states. Additionally, Amtrak is a professional transportation services organization successfully operating suburban rail services in several cities coast to coast. Our success in these endeavors is the direct result of our pioneering efforts in the Northeast Corridor. New techniques, new machinery and innovative maintenance-of-way methods were created in conjunction with many companies represented here today in the railway engineering supply fields. It is also important to recognize that Amtrak and many of American's freight railroads have established a partnership founded upon a common understanding that operating passenger trains is not that different from operating time sensitive intermodal freight trains. Passenger services on behalf of Amtrak, when properly and efficiently run, are a business opportunity that contribute to the financial success of many of your employers. As Amtrak looks ahead into the next century, the future of rail passenger service in the United States is most certainly alive, healthy, and contributing to the well being of the nation by providing essential public transport that is fuel efficient, comfortable, and reliable. It is also a travel alternative that can reduce airport and highway congestion in major travel corridors providing a lower cost infrastructure burden on the taxpayer.

A Growth Plan for the Future

To meet the needs of American travelers, Amtrak has embarked upon an ambitious program of renewing its diesel locomotive fleet, acquiring new passenger cars, and upgrading its high speed Northeast Corridor infrastructure anticipating speeds of 150 miles per hour with modern streamlined trainsets similar to those of Europe.

In 1993, the General Electric Company will deliver the first locomotive in North America designed especially for passenger service since the 1940s. These units will have a streamlined car body based upon the German Intercity Express locomotive, integrated electronics and microprocessor control, and a safety designed operator's cab to allow our employees to work comfortably and efficiently for periods of eight hours. Our new locomotives will be collecting data on-board to alert us to problems before they become emergencies, and to allow our workshop personnel to plan their maintenance efforts in the most cost effective manner.

In July, 1993, Bombardier Corporation will deliver the first of 140 double-deck superliner passenger cars to be used on western routes and to re-equip three eastern trains where clearances allow the cars to operate. Our superliners are the most popular car type in the Amtrak fleet, providing an average 80 percent increase in capacity over single level passenger stock currently being used. The superliner acquisition will also improve accessibility for the disabled community as required by the recently enacted Americans With Disabilities Act. We anticipate awarding a contract for our new single-level sleeping car Viewliner before the end of 1992 to upgrade the remaining long distance trains in the east.

The Boston to Washington Northeast Corridor has shown continued growth. Airport congestion in New York and Boston has led the Federal Railroad Administration and the Congress to authorize the 134 mile extension of electrification between New Haven and

Boston. Amtrak has awarded a contract to Morrison-Knudsen to accomplish this work. With the completion of electrification in 1996, Amtrak will be able to reliably offer three hour service between New York and Boston. With travel times reduced, many of the Boston airport short-haul slots can be reallocated to long-haul needs where the airplane functions best.

To improve ride quality, we have converted 50 open deck bridges to ballasted decks using our own concrete precasting facility. This program continues with over 100 bridges left to do in anticipation of higher train speeds and in our efforts to reduce maintenance costs. Further reductions in trip time are possible through a series of line improvements, signal enhancements, and possibly tilting equipment.

In 1993 the X2000 Swedish high speed trainset will be demonstrated on the Northeast Corridor for approximately six months. The information gathered will be used to develop specifications for a North American trainset. All of our planning contemplates a maximum speed of 150 miles per hour.

The expertise of the past 15 years places Amtrak in a dynamic role to assist additional high-speed rail projects in other regions. We have been working with developers and government bodies in New York, Florida, Texas, Washington State, California, Michigan, Illinois and several other states to support high-speed rail in the eyes of the public. We are also involved with the proposed Magnetic-levitation demonstration project in Orlando, Florida. Amtrak also brings to new ventures a known entity with a proven borrowing and financial record, an established passenger reservations system, and an understanding of the American transportation marketplace. Our technical knowledge of the Code of Federal Regulations, and an experienced workforce skilled in the maintenance of high-speed railway and transportation communication infrastructure, allows us to offer our expertise to any and all parties contemplating new railway projects.

Similarly, our operating and maintenance expertise is regularly sought from state and regional rail authorities to operate suburban and interurban passenger services. Since 1987, Amtrak has operated the suburban rail services of the Boston Commuter Authority, MBTA. Another example of our success is the Maryland commuter service between Baltimore and Washington. In June, Amtrak began running the new Virginia Rail Express service into Washington. In July, we took over the San Francisco-San Jose service and extended operations to Gilroy, California. Next month, we will commence operations for Los Angeles County Transportation Commission when their "Metrolink" commuter rail service debuts. Amtrak brings to these agencies an established management team, an experienced maintenance of equipment and maintenance-of-way maintenance force, and a highly visible, recognized marketing organization.

Leadership in Maintenance-of-Way

In the Northeast, Amtrak owns and maintains its tracks, bridges, signal equipment, and infrastructure. To more efficiently do this work, we have pioneered a number of innovative practices that have subsequently been adopted by other American railroads. Amtrak was first with the P811 track laying machine in 1978, the dynamic stabilizer in 1984, and the MDZ concept for surface and alignment operations that combined continuous action tampers with the stabilizer to restore full track speed of 125 miles per hour within 24 hours. We have begun replacing our catenary work trains with self-propelled catenary vehicles, better equipped to do the construction and maintenance at far less cost. We have recently received an automatic ballast distribution system to place our ballast precisely where it is needed, again without a work train locomotive. For interlocking surfacing, we will be connecting two surfacing machines together electronically to adjust both ends of our No. 20 crossovers simultaneously. We are currently procuring a modern turnout installation machine patterned after one in service on the Belgian Railways. It will be used to install our new 80 miles per hour high speed turnouts in New England next year. Based upon Amtrak design parameters, the machinery has been redesigned for our specific needs of installing tangential geometry turnouts on large concrete tie panels.

Amtrak was also the first railroad to install No. 30 high speed, movable point frog turnouts on exotic hardwood ties. In 1983, we developed concrete switch tie sets for both movable wing rail and heavy duty spring frog turnouts. We also pioneered the use of the wheel impact detector systems in the late seventies that many freight railroads have since improved and installed. We have developed our own design of swing bridge miter rails, capable of speeds in excess of 60 miles per hour with impact forces less than conventional miter rails. Also in the bridge area, Amtrak was one of the first railroads to remote control a movable span using video observation, a practice that is becoming more common.

Our signal infrastructure and data acquisition network continues to be modernized. The Philadelphia Control Center now operates the railroad from Washington to Philadelphia, with further extensions underway from Philadelphia northward toward New York City. It was the first video projector control center in the country. In New York City, a new control center is under construction to control 26 miles of terminal area lines shared with the Long Island Rail Road and New Jersey Transit. The Boston Control Center will have its responsibilities increased as electrification is completed in 1996 between New Haven and Boston. All told, these signal projects will eliminate over 20 wayside manned, switch control locations while providing improved operating flexibility to our operating officers.

Amtrak is the owner of valuable real estate in prime center city locations. Our station development projects improve our stations in major cities to increase the value of our adjacent land and air rights. These improvements also improve the image of Amtrak to both the traveler and to the people meeting or greeting rail passengers. The $170 million renovation of Washington Union Station has become world renown. But most importantly, the retail shops and services of Union Station are making financial contributions to Amtrak's operating and capital needs. A similar project in Philadelphia has renovated 150,000 square feet of space for Amtrak's needs as well as restoring much of the original architecture commissioned by the Pennsylvania Railroad in 1931. Here in Chicago, Amtrak has just completed the reconstruction of the intercity and commuter rail portions of Chicago Union Station to increase revenue and drastically improve the quality of the rail travel experience. The short-sighted demolition of the 1960s has been corrected and all users of Chicago Union Station have a hospitable and functional facility. We are now proceeding with the total renovation of the special trackwork and signaling system in cooperation with METRA, the local commuter authority. I would like to just pause for a minute while we're talking about Chicago Union Station and make special note of the contribution that Mark Walbrun, president of the B&B Association here with us, made to that. Mark was the fellow who really had the foresight and the vision to see what Chicago Union Station could be and although there were a lot of stumbling blocks to overcome in bringing this station to what it is today, he did not flinch for one minute in pushing forward with his ideas. I would just like to recognize that today. Without Mark that station would still be what it was prior to when we started. (Applause) There's an interesting and an excellent article in Railway Track and Structures on Chicago Union Station and I would recommend it to any of you who are interested.

Based on our experiences in Washington and Chicago, a first class station facility creates an interest in rail travel among persons who have not considered train travel.

Conclusion

The ever-increasing congestion in airports, on the interstate highways, and in urban highway corridors has made the U.S. Congress and public officials at all levels recognize the value of an integrated multi-modal transport system of which the Amtrak rail passenger service is a key component. To achieve parity with the other modes, it is critical that the intercity capital needs be properly funded. Just as there are airport and highway trust funds, Amtrak believes there should be an Intercity Rail Improvement Trust Fund created and supported by an automobile gasoline tax contribution. These intercity rail improvements have the potential to reduce highway congestion in densely traveled corridors in all areas of the nation, as well as improve infrastructure on shared rights of way with the freight railroads.

Offering a quality service to over 500 destinations, coupled with a growing demand for intercity services and a growing concern for the environment makes the future of rail passenger service in the United States very bright indeed. As we evolve over the next ten years, we look to our partners in the freight sector, the members of the railway engineering supply industry, and the technical and professional organizations such as B&B and Roadmasters, to provide Amtrak and the railway industry with the resources to deliver quality transportation that this country needs and deserves. Thank you for your attention. (Applause)

President Walbrun: Thank you, Mr. Sullivan, for those kind remarks. For those of you at the head table, if you would like to move down, the next presentation will involve some video. At this point I would like to turn the conference over to Ray Brosseau, conference program chairman for the Roadmasters.

Mr. Brosseau: Thank you, Mark. Our next feature is the proposed new double stack railway tunnel under the St. Clair River between Sarnia and Port Huron. The presenter is Keith Nordlund, project manager for CN Railway. Keith graduated from the University of Toronto with a degree in civil engineering and has been employed by CN for over 25 years in the engineering department at various locations in central and western Canada. Keith is currently CN's project manager for southwestern Ontario, coordinating the activities on the Canadian side for the tunnel projects.

PROPOSED NEW DOUBLE STACK RAILWAY TUNNEL UNDER THE ST. CLAIR RIVER BETWEEN SARNIA AND PORT HURON

D. Keith Nordlund

Project Manager
CN Railway

Thanks, Ray. Of course you probably know that Ray is with CP Rail and a friendly competitor in Canada. I see by this morning's itinerary that we have the Chicago Tunnel Leak coming up later on and Ray assures me that he wasn't trying to set up CN on this one. (Laughter)

This morning's topic is CN North America's proposed new double stack rail tunnel linking Canada and the United States. It's a world class project for CN and it is indeed a pleasure for me to be here to give you some idea of the engineering challenge facing us. It's a challenge to not only carry out the work safely, but also a challenge to meet extremely tight time targets. I have some 60 slides and I think you'll find them very interesting. We may have a few minutes for some questions and answers afterwards.

You are probably now becoming more aware of the new business identity for CN and the Grand Trunk.

This project was given the green light at CN nine months ago and we are now just beyond the mid point of a 15 month preparatory phase. Our target, believe it or not, is to start moving double stack trains through the tunnel two years from the date of this conference.

CN has just recently incorporated a wholly-owned subsidiary, the St. Clair Tunnel Construction Company, to finance and construct the new tunnel. Upon completion the tunnel will be turned over to a second wholly-owned subsidiary, the St. Clair Tunnel Company, which will operate the new tunnel.

This rendition illustrates the new tunnel passing under the St. Clair River. This river is an integral part of the Great Lakes and St. Lawrence Seaway system. CN North America does have a century old tunnel at this location now but, unfortunately, it's just too small to handle the new generation larger cars. So, 100 years later we are now making major improvement to this critically important river crossing.

This map will help orient you to the geographic location of the project. At the bottom end of Lake Huron is Sarnia and Port Huron is on a direct line from Toronto to Chicago. Sarnia is a strategic location for CN and with this project will become further entrenched as CN's dominant international gateway.

At Sarnia we now cross the river by two means, a less than standard clearance tunnel and a barge service. Our line in Canada is double track with CTC and some ABS. In the United States the double track is block signalled with some single track CTC sections.

For well over 100 years Chicago has been, and still is, a prime rail hub of North America. According to current estimates, approximately 60 percent of all U. S. rail movements pass through Chicago. Therefore, effective access to Chicago is a key factor in CN North America's future.

CN has a very active presence in Sarnia. Well known as an international chemical center, Sarnia is a major producer of both fuels and chemicals as well as a major consumer of raw materials in their manufacture. This industry is particularly well served by rail to and from the U.S. and this keeps a significant amount of dangerous commodities off both of our nations' highways.

What doesn't move by rail across the river moves via the Bluewater Bridge. The combination of heavy trucks mixed with passenger vehicles produces the expected amount of congestion at times. Various studies have pointed to the need for additional bridge capacity, something that could possibly be held at bay depending on our success in attracting domestic doublestack traffic.

This is a bird's eye view that illustrates CN's proposed tunnel in red and the existing tunnel in yellow.

The total tunnel length is just over 6,000 feet, split almost evenly into three portions. Two thousand feet is under the river and 2,000 feet under each of the land approaches. You can see the significantly built up areas along the tunnel alignment. On the Sarnia side, our ferry slips are approximately one mile north of the tunnel. The slips are immediately north of the tunnel on the Port Huron side.

Vidal Street is on the Canadian side and 16th Street on the American side. I will be talking about these later.

On the St. Clair River, there are 20,000 annual ship movements including railway barges and pleasure crafts.

This is one of two CN barges that today handle the large type rail cars. For a through route operation that is sensitive to customer service requirements, barges are a weak link. Our barge traffic is primarily automotive, finished autos, as shown, and hi-cube parts cars. CN's volumes, by barge, are significant in the neighborhood of 75,000 rail cars annually.

CN does not handle doublestack cars on the barges. This traffic is routed through the Buffalo gateway but will be rerouted through the more attractive gateway at Sarnia when the new tunnel is opened.

The tunnel was constructed under the Direction of Joseph Hobson, chief engineer of the St. Clair Tunnel Company. It was one of the great civil engineering feats of the day.

This was his profile for the section under the river. You will note that Hobson positioned

The St. Clair River
International Tunnel Project

the tunnel with a fair degree of precision midway between the bed of the river and the shale bedrock.

This is one of two 21 foot shields being lowered into the portal excavation, a cut-away of the shield and cast iron tunnel liner as work progressed. The shield was propelled forward by 24 hydraulic jacks bearing against the then newly installed cast iron liner. Workers on platforms within the shields cut away the clay by hand, and as the shields advanced, follow-up workers lined the tunnel excavation with the cast iron segments using the mechanical erector arm. When the work started under the river, solid eight foot thick brick bulkheads were built just behind the shields and the work area was pressurized to avoid the possible collapse of the excavation face. The compressed air was a minimum of 10 psi and as high as 34 psi at times. Little was known of compressed air at the time and cases of the "bends" were numerous. The men were given an extra one dollar a day to cover the danger. Much of the earth removal was by mule drawn muck cars. Hobson tried horse power, but the horses could not perform in the compressed air. This slide shows the meeting of the two shields after 12 months of tunnelling. The two shields were left in place and are there today.

One of the first generation rail car ferries was replaced by the tunnel. Interestingly, 100 years later we will be replacing the second generation ferry system.

The old tunnel is historically important and is recognized as an engineering achievement of national and international significance. This plaque, a dedication by the Canadian Society of Civil Engineers, sits under a commemorative arch which is made up of surplus segments from the century old tunnel bolted together and reads:

"First International Tunnel"

"At this point the Grand Trunk Western Railroad tunnel, linking Port Huron with Canada, passes underneath Military Street. This international submarine railway tunnel – first in the world – was opened in 1891. The tunnel's total length is 11,725 feet (this refers to "summit to summit" distance), with 2,290 feet underwater. The tunnel operations were electrified in 1908 (was initially steam) and completely dieselized in 1958. Tracks were lowered in 1949 to accommodate larger freight cars. During World War I a plot to blast the tunnel was foiled."

The old tunnel has also been recognized by the State of Michigan, the American Society of Civil Engineers and the Province of Ontario. Recently we received a copy of a letter from Washington to Ottawa proposing that both countries jointly give "national recognition" to the original tunnel.

Now to go on to this century's project. Duncan MacLennan is the chief of the project for the St. Clair Tunnel Construction Company and Jim Anders, my counterpart, is responsible for the activities on the United States side of the border.

Initial momentum for a major upgrading of the river crossing at Sarnia started in early 1991. That's a little over a year and a half ago. This was mostly an "in-house" pre-feasibility level of study. The mandate was to consider the costs and weigh the benefits of either expanding, or replacing, the old tunnel to modern day standards and clearances. This initial study outlook was positive and was presented to CN's executive board. Immediately afterwards, CN retained the Canadian consulting firm Klohn Leonoff to do a full level $1 million study to examine in more detail the most cost effective method of a new full clearance crossing.

Since that time, consultants, Hatch Associates of Canada in a joint venture with Mott MacDonald of Britain, were retained to carry out the detail design and specification phase. This is now well on its way. Klohn Leonoff have continued on with the project in obtaining the necessary approvals and permits.

During the early study phase, various alternative methods for crossing the river were considered. A number of weighted factors were used in the selection process such as effects on the environment, rail noise impacts, and other factors not the least one being costs. The most cost effective and environmentally compatible option was chosen.

Very briefly several schemes were looked at in enlarging the present tunnel. Expanding meant closing down the tunnel during reconstruction and diverting traffic. This had significant incremental costs and potential loss of market share during the down time. The enlargement scheme also carried with it the risk factor of failure during reconstruction, particularly under the river section, and completely losing our asset, "The Old Tunnel". Not at all a thinkable scenario.

For the two "New Tunnel Options" the pillar referred to is the column of earth between the old tunnel and the new. In the case of the 33 foot pillar, certain work would have to be carried out to stiffen the existing tunnel to ensure stability during construction of the new. The 80 foot pillar provided sufficient separation and would not affect the stability of the old tunnel. This was the chosen option. We have since optimized to about a 63 foot (19 meters) pillar.

The "Rock Tunnel" would mean going deeper to below the 100 foot clay layer. This would increase the length of both the tunnel and adverse approach grades and had significant construction and future operating costs.

The Sunken Tube Option, with precast sections floated to the site, would require trenching of the river bed and would raise serious environmental concerns and would probably add a year or two to the governmental approval process which would be unacceptable. It was also a more costly alternative.

The Bridge Option would have to provide substantial clearances, 135 feet overhead and 600 feet sideways, for seaway traffic. We would have to shift both Sarnia and Port Huron rail yards which would be a major cost in itself to accommodate the very long approach grades.

The feasibility study and a more reliable cost estimate was completed after four months of intensive research and analysis. Construction of a new tunnel was clearly the recommended option. It would be north of the existing tunnel and the crown of the new tunnel would be approximately at the same elevation as the existing one. The diameter would be such to permit doublestack service. Less than ten months ago the CN Board approval was given to go ahead with the project in its entirety.

In this slide you see a partial list of United States agencies and interested parties. The potential of encountering contaminated or hazardous materials is considered slight and that almost all the excavated material will be suitable as general construction fill. However, soil will be monitored throughout the construction phase and contingency plans developed in the event some contaminated waste is encountered. Finding sites for the disposal of the clay excavation will not be a problem as there is enough local interest that the demand will probably outstrip the supply. The obtaining of environmental and regulatory approvals is proving to be a long, and sometimes very sensitive, process.

On this slide is a partial list of the Canadian agencies. This project, being truly international, requires approvals from both Canada and United States interests. A total of 200 interested parties have been contacted over the past year.

Four public participation meetings were held in the U. S. and Canada and many presentations were made to the key permitting agencies.

This is an artist's rendition prepared during the feasibility study of the Canadian portal illustrating the old and the new tunnels. At that point in the study the new track, shown to the right, was to be about ten feet lower than the existing rock profile.

We have not yet decided what we will do with the old tunnel. It will not be required for rail purposes. We are entertaining thoughts to utilize it as a utility corridor as an alternative to filling it in.

The total project will require excavation and disposal of a half million cubic yards of primarily clay material. Thirty percent will come from the tunnel itself for disposal in

Canada. The concrete block building on the right will be the only building on the Canadian side to be affected by construction. This photo was taken from the Vidal Street overpass.

This photo is looking in the opposite direction towards the Vidal Street overpass. The train has just exited the tunnel. The road bridge pier to the left of the track will require only minor modifications to the pile cap to accommodate the new track alignment. The superstructure of the bridge will not be affected. The train in this photo is the tunnel transfer powered by four captive units known locally since the turn of the century as the "tunnel motors". Their job is to shuttle Plate C traffic between Sarnia and Port Huron. Almost all through trains that arrive at the Sarnia gateway must be split out between cars that will fit the existing tunnel and cars that must go via the barge. Talk about a bottle-neck!

This is a closer view of the Canadian portal. As you can see, the existing tunnel and the planned new tunnel go under the Esso Research building. Imperial Oil has a substantial tank farm back of the building. Many years ago there was double track down close to the portal. This was eliminated when signal improvements were introduced.

This is a photo from the American side looking towards Canada with the new tunnel alignment just ahead of the bow of the ship. There is a deep sheet pile retaining wall and catwalk with intermediate pylons that extend well down into the river bed. It took some jockeying at the design stage to pick the best alignment between the various sub-surface obstructions.

This is a photo of the tunnel approach on the American side. The new tunnel will be off to the left. Those are jib cranes on a ship that is docked. The Port Authority building in the background is on the alignment of the new tunnel.

This is the only level crossing affected. It is 16th Street on the U. S. side. The track will be lowered some six feet through this crossing to accommodate the new tunnel profile.

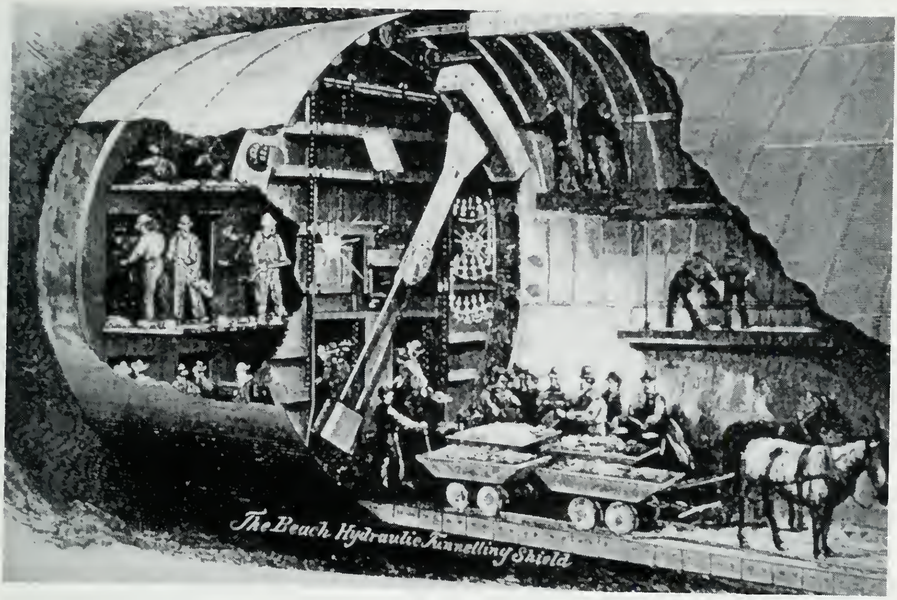
This is a photo of the riverbed soil testing, in addition to land drilling, that went on during the feasibility study. The barge was anchored and bore holes were kept just outside the outer limits of the proposed alignment. We certainly would not want to be running into bore holes when tunnelling otherwise we would have a sudden start in draining the Great Lakes system. In addition, geophysical testing was carried out to support the selection of the preferred alignment. Recently, more riverbed drilling, particularly in the critical areas, has been carried out. Experienced tunnellers reinforce the principle that the more geotechnical knowledge you have prior to construction reduces the risk and claim exposure to the client. This certainly has our interest.

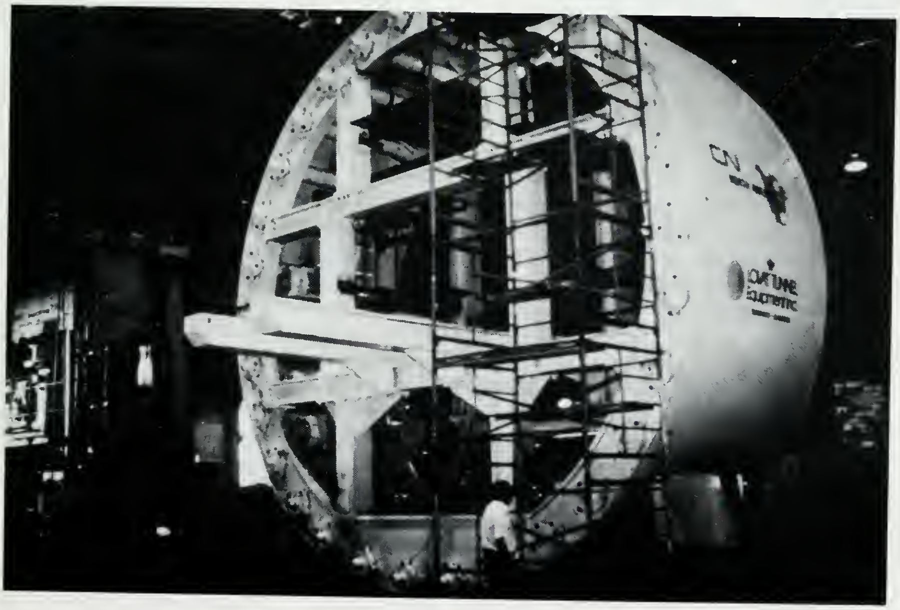
This slide is a plan and profile. In the plan view the new tunnel is shown in red. Looking at the profile, summit to summit is about two and one-half miles. Each of the approaches is about one mile in length with a two percent grade on the Canadian side and slightly more on the U.S. side. The grades approaching the existing tunnel are two percent.

The new tunnel will permit 50 miles per hour operation, much improved over the current 15 miles per hour through the old tunnel. The entry/exit tracks beyond the new summits will be designed for high speed operation to take advantage of momentum train operation.

This is a closer view. Again, looking at the plan view, the horizontal tunnel alignment is primarily tangent with two zero degree 30 foot curves in the tunnel under each of the land sections. The offset centerline between the two tunnels is 89 feet (23 meters). This alignment was found to be the most cost effective, given property constraints, geotechnical conditions and surface and subsurface obstructions.

Shown in yellow in the present riverbed is a gravel-sand alluvium. The green are the open cut areas of the approaches. The gray is a 100-foot layer of clay known as St. Clair till. It is described as a firm to stiff category of clay. Below the clay and shown in a rusty color is shale bedrock. Colored in gold just above the shale is a thin overlay of sand and silt till which contains a fresh water aquifer. Of interest is the bedrock valley, over a quarter of a mile wide, which is a riverbed just to the right of the present river.


The Beach Hydraulic Tunnelling Shield


CN

The crown of the tunnel is roughly the same as the old tunnel, about 15 feet under the riverbed. The tunnel invert will just skim the top of the shale rock bed.

This profile view, in particular, illustrates the challenge of the project. You can see the extremely narrow working zone we have between the relatively solid shale and the top of the clay and the riverbed. There's no room here for mistakes or getting it right the second time. When we are tunnelling under the river we will be running a 24-hour operation, seven days a week.

This is a cross section on the Canadian approach. The depth of cut is less than 60 feet. Note the existing track is to the left and the new track just to the right. The excavation is shown in green. The new track, being about three feet lower than the existing track, is set in a 26 foot clear area between retaining walls. The construction of retaining walls has optimized the amount of excavation required. The slopes will be 1:3 (vertical to horizontal) equivalent to today's slopes with mid-slope benches for stabilization.

The inside tunnel diameter will be approximately 27 feet. The clearances are to full AREA standards and more than sufficient for today's doublestack configuration with nine-foot, six-inch containers. Our plans call for constructing the track on a standard ballast section. There is an option for the long term future of electrification by lowering the track profile and placing the rails on concrete slab.

Provision will be made for ventilation, fire protection and utilities. The concrete bench design provides AREA clearances at the bottom sides, provides a safe location for the fiber optics and gives more mass to the tunnel further decreasing the buoyancy effect of the tunnel.

The tunnel liner will be installed in a single pass using pre-fabricated, reinforced concrete segments, gasketed and bolted to very tight tolerances. The placement pattern of the tunnel liner segments will be as shown.

This is the detail for a segment and key segment off to the left. The main segments are approximately 15 feet by 5 feet by 16 inches thick and weigh seven and one-half tons. The more than 8,000 concrete segments are expected to be shipped by rail to the project site. I am sure that you can appreciate that strict quality control will be critical for all the phases of manufacture, storage, transportation and installation for each and every segment. We are looking for a quality job and a dry tunnel.

This is the detail of inset bolts tying the segments together. The notch near the top is for the waterproof gasket.

This is the latest rendition of the Sarnia portal. The new portal extends some 50 feet out from the face of the existing portal. The portal of the old tunnel was constructed with stone blocks. Some thought was given to salvaging blocks in the immediate area to extend a similar facade for the new portal and retain uniformity. However, discussions with interested historical groups is now leading us to build the new portal with a somewhat different type of construction and protect the historical significance of the old portal facade.

The portal extension will be of cut and cover construction and will be part of the assembly area and the so-called "launching pad" for the tunnel boring machine. This structure behind the portal face will eventually house the mechanical and electrical support systems for the tunnel.

This is an artist's rendition of the old and new construction. Modern tunnelling is strikingly similar in the basic concept, with a shield, although with today's technology the men will not be required to work under compressed air. The new Sarnia tunnel will be constructed with a tunnel boring machine, TBM. The contract to design and build the TBM has been awarded to a Canadian-based manufacturer, Lovat Tunnel Equipment, at an approximate value of $15 million Canadian.

This is a schematic of CN's giant mole. It will have an overall outside diameter of 31 feet (nine and one-half meters). This machine is designed with a cutting chamber that will maintain continuous pressure on the excavation face. In the industry, this is known as an

Earth Pressure Balanced (EPB) Tunnel Boring Machine (TBM). The balance of pressure on the excavation face will be controlled by the operator by means of the degree of door face opening, the rate of removal of muck from the cutting chamber and the forward rate of progress of the tunnelling machine.

You will note the screw auger that takes the excavated material from the cutting chamber back to the conveyor belt. The erector arm is holding a segment ready to move forward for placement. The 100 ton working pressure pushing jacks, of which there are 30 around the circumference, are shown in an almost extended position for bearing against the tunnel liner. The tunnel liner is assembled entirely within the skin of the TBM. As the TBM advances, grouting is placed in the void left by the TBM shell. The electric driven TBM is powered by almost 4,000 horsepower.

This is a photo of a typical TBM. This unit was manufactured for the construction of the Metro Line in Toulouse, France. This machine is a closed face design for soft ground tunnelling with slots that open for material excavation.

This is a photo immediately following a hole-through. You can see the machine is in the open face position where the teeth rotate at about four revolutions per minute forcing the earth into the open slots.

This is another TBM manufactured in Austria. This has been referred to as the "mother of all TBMs". It is 38 foot in diameter and is currently working on a six and one-quarter kilometer project for the Swiss Railway.

This TBM worked for the French side of the Chunnel Project and was a joint Japanese/American manufacture. You can see that tunnelling is very international, no pun intended when referring to our project.

This is the summary master project schedule. Of the various major activities, the tunnel contract mobilization and construction is on the critical path. The tunnelling schedule is based on an overall average advance rate of 25 feet per day. In other words, that will be five complete rings installed every 24 hours. During the eight to nine month tunnel drive, the soil disposal will be in the range of 100 truckloads each day, around the clock, seven days a week.

This is an overview of our time frame. The tunnel is scheduled to open in late 1994. The overall project duration is 33 months. The clock has been ticking and we now have only 24 months left and we are on schedule.

I think you will find it interesting that the contractual option chosen for the project is the Negotiated Compressed Process. This process has parallel activities of "Tunnel Design" and "Selection/Ordering of TBM". This is the key element of the 33 month project duration. In other words, the TBM is designed and fabricated while, as a parallel activity, the tunnel is designed and tenders called for tunnel construction. This process does require the prequalification of tunnel contractors at a very early stage and their agreement to jointly participate with CN in the design specifications of the TBM. In this manner, CN maintains a competitive bidding process for the project. The conventional process would have been to first complete the detail design, then call tenders for the tunnel construction and the successful tunnel contractor would be responsible to supply the TBM. We have chopped a year off a conventional schedule.

A world-wide pre-qualification of tunnel contractors was done in February, 1992. The selected pre-qualified construction consortia, in their first task, participated with CN in a committee to set the specifications of the TBM. After deliberation, all parties agreed that the job could and would be done with the machine as designed. CN placed the order for the TBM in March, 1992. If a contractor hadn't agreed with the boring machine design, then he would have withdrawn from the committee and the opportunity to bid on the project.

This is a listing of the dozen individual contracts. The major ones, in addition to the TBM and tunnel construction itself, are the tunnel liner segments and the excavation on each of the approaches.

Preparatory excavation and retaining wall work is scheduled to start late this year in the specific area of the Sarnia portal. This is to prepare for the arrival and site assembly of the TBM next spring. Tunnel construction is scheduled to start in April, 1993.

When it is all done in two years, we will be moving doublestack trains under the St. Clair River between our two countries.

This project is a major civil engineering challenge in soft ground tunnelling. But more importantly, from a business perspective, it is CN North America's opportunity to meet the challenge of the changing trends of the marketplace. It is our chance to compete and maybe have a leg up on our major competition, the trucker.

That covers all the slides and I'd be pleased to come back in two years and describe the "as constructed". Thank you for your attention. (Applause)

Mr. Brosseau: Does anyone have any questions for Keith?

Mr. Mitchell: What's the total budget for this project?

Mr. Nordlund: $155 million was identified in the public press in the total overall project. That $155 million not only included the construction of the tunnel but it included some improvements in the track changes up in the terminals, because obviously we are changing our overall operating scenarios. We'll be blocking some trains and running truly through trains.

Member: Do I understand that you are boring your tunnel in one direction only? Which portal are you starting from and how was it determined whether to start from the U.S. or the Canadian side?

Mr. Nordlund: I guess one principal was that it was a Canadian project and so we started from the Canadian side. We did get into some discussions and we looked at both critical paths in terms of getting approvals. We did debate one side versus the other, they were both close. In terms of acquisitions of property we were into a little tougher situation on the American side. There are two buildings with adjoining properties that we would have to acquire. On the Canadian side, that block building that you saw was not directly involved with the initial startup of the project, so we felt more comfortable on the Canadian side. All those reasons were valid along with the principal, it being a Canadian project.

Mr. Brosseau: Thank you very much, Keith, for that very fine presentation. Our next feature is entitled "Investing in New Track Technology" presented by Vincent Terrill. Vin is currently a rail and track consultant. He received is B.S. degree from the University of New Hampshire in 1951. Vinnie held the position of vice president with the Boston and Maine and chief engineer of the Maine Central. He was president and chief executive officer of Pandrol Jackson and is currently a director of Pandrol Jackson. His professional affiliations include membership in the Roadmasters and Maintenance of Way Association and AREA's Committee 4. Vinnie is a past president of REMSA, Past Governor of RPI, and Past President of AREA. Vinnie.

INVESTING IN NEW TRACK TECHNOLOGY

Vincent R. Terrill

Good morning. Thanks very much, Ray, for that concise introduction.

Everyone in our industry is talking about cutting costs, increasing productivity and producing a quality product. In the process, we are discovering that by working together—railroad with railroad – railroad with supplier, we not only save money on elimination of duplication of R&D but we can produce a quality product which will increase productivity, thus showing a budget saving for the railroad and a profit to the supplier. Profit is a little used word in our industry, generally used in a negative sense; i.e., "They profited by their loss." Or, "I smashed up the car, sweetheart, but I figure that we will profit by that if we use the money we save on gas to make the rest of the car payments."

Suppliers, like the railroads, must stay competitive to stay the course. The rash of mergers and buyouts are piling up along the course and the finish line is not in sight.

REMSA is a way for suppliers to come together to fend off the real enemy out there running on the government-built, state-maintained highways. It is also a way to share rental costs while showing our innovative and highly competitive products. We will be doing that at Denver in September, 1993. This will be the biggest maintenance-of-way show in the world even though it comes four months after Frankfurt, Germany. Wait and remember my prediction.

Innovation aside for a moment, REMSA has taken this cooperative effort one step further by becoming a charter member of the Rail Supply and Service Coalition, a five organization group comprising 900 companies whose sole non-profit purpose is to promote policies that foster the development and maintenance of a strong integrated national freight passenger, transit and hi-speed rail transportation system. Through this coalition, we recently helped AAR obtain research and facility rehab funds so that they could continue their research and development work which has helped lead North American railroads to their enviable records in safety and productivity.

What I am trying to say here is that REMSA is into cooperative effort to support the industry, because if we don't have our railroad and transit customers, all the effort put into innovation, quality and productivity will not pay the car payment or the mortgage. REMSA's new face and modern upbeat tone is largely a work of Judi Meyerhoeffer, executive director, and her assistant Helen Pape. If you haven't seen our modern, informative Newsletter, take the time to get one from the REMSA table outside this room. The faces of the president and Board of Directors continue to change but the stable office and face of the executive director goes on forever. I know that you could have lived with my face – there's so much of it – but it's tough to take more than a year of Josef or Jerry Hines or Ken Norton, so Judi remains as an intelligent stable force and she and Helen with REMSA Board direction have led REMSA into a new realm of professionalism and political activism. We are playing a stronger role in supporting the railroads and the Association of American Railroads. We continue to foster education and knowledge through scholarship and support of Roadmasters, B&B, AREA, and AAR rail and bridge committees and to provide the necessary communication and social networking which helps make our industry, and particularly the maintenance-of-way portion, as strong and viable as it is today.

We are going to be talking about investing in new track technology here this morning and I will be showing you materials and equipment that some of you railroaders have helped develop. Sometimes the idea comes from a railroader; and most times final testing is done on your tracks and all of the time you, the customer, are the final judge. If you don't like it then it does not get produced. We want to thank the Roadmasters and Bridge and Building organizations for giving us this time to show some of our working innovations and a few still in the R&T mode.

Again, mark a date on your calendar for the week of September 19 through 23 for the next Roadmasters-B&B-REMSA extravaganza which will include the REMSA equipment show and the Transportation Research Board symposium on innovations in maintenance-of-way work equipment which will follow the equipment show in Denver and incidentally be chaired by someone called T. Smithberger with my assistance.

Now thanks to the suppliers who sent me the slides and the words of wisdom – oh yes, remember: Everything that I read from here on is from the manufacturer and/or supplier. Do not read my lips – from here on, these are not my words. Hold your questions and comments for the supplier representative. It might be well to jot down your questions with the company name so we can find the right person to ask. Even with all of our sense of brotherhood, there's still plenty of competition left within the REMSA ranks and we would not want to ask Abel about Cain's latest style weapons!

(Whereupon there was a slide presentation with the following comments)

Chemtron E-Z Throw

In 1989 REMSA member company Chemetron Railway Products, Inc. introduced a new and unique switch stand called E-Z Throw. This rotary wheel manual operation switch stand offers significant ergonomic and safety benefits to our industry.

First, E-Z Throw switch stands offer a 17 to 1 force ratio. This is typically two to three times better than most other switch stands.

Second, the E-Z Throw switch stand is operated by one 360 degree revolution of the chest-high wheel. Operator bending, twisting and lifting is minimized and risk is greatly reduced. The stand is a direct retrofit from most switch stand locations where clearances allow a tall stand. The E-Z Throw switch stand is offered in two models, one using a fully adjustable bottom crank-eye connection, as shown here, and a standard top crank connection. This patented switch stand first developed by Ed Kohicky, roadmaster for the Union Pacific, and John Butler is now being exclusively manufactured and sold by Chemetron Railway Products and True Temper Railway Appliances.

Two major U.S. railroads are taking advantage of the benefits offered by E-Z Throw and numerous others are reviewing this new design switch stand.

Unit Rail E-Z Wrench

Innovative technology can sometimes come in a small form. The Unit Rail Anchor Company invented and received a patent on a new type of anchor wrench dubbed the E-Z Wrench to put on spring anchors. For over 60 years trackmen have had to use a bar type wrench that requires considerable force to engage spring anchors in track. In addition, this wrench sometimes caused back injuries which was of concern to the railroads. It took Unit one and a half years to develop a wrench that could apply all sizes and types of spring anchors that would use a mechanical advantage to aid in the application of anchors. Once the tool is positioned on the anchor as shown here a direct push in a downward motion is all that is required. The face plate is engaged against the ball of the rail and uses a leverage action through the linkage to reduce the force required to be put on the anchor. This tool allows the trackman to apply the anchor using approximately 50 percent less force than the old bar type wrench. Notice on this slide that the hands finish at approximately knee height at the end of the application push. Using this tool properly will allow the safe application of spring anchors and help us to eliminate back injuries. The company makes the wrench to apply the Woodings, True Temper and Unit spring anchors. The E-Z Wrench has received high marks from several railroads that have used the wrench in the field.

Osmose ADZ Pads

As another rail relay season begins so does another opportunity for decay fungi to attack and destroy wood. The adzing of ties combined with a moisture inherent to the tie plate area creates a perfect mix for the growth of decay fungi within the tie plate area. Recent environmental legislation coupled with employee health concerns were viewed as a barrier to effective tie treatment. This situation is not acceptable as you try to get the best return for this important track asset. ADZ Pads from Osmose is a biodegradable preservative pad to be used during rail relay for adz tie surfaces. Each pad is 6 inches by 12 inches by l/8 inch and contains 35 grams sodium flouride, the active ingredient. The sodium flouride component is held in place by a water soluble glue designed to slowly release the sodium flouride in the presence of moisture. Test plots on several major Class 1 railroads testify to ADZ Pads' ability to penetrate oak ties to a depth in excess of one inch in toxic quantities. ADZ Pads will not affect spiking or gauging activities. Due to their chemical makeup ADZ Pads are not affected by rail heating operations, nor do they pose health risks for railroad employees. ADZ Pads are packaged in plastic lined cardboard boxes containing 450 pads per box. ADZ Pads carry an EPA pesticide label. This label is general use allowing railroad employees to handle the product without undergoing special precautions, courses, etc. ADZ Pad has no odor and it's composition remains constant even in temperature extremes.

Orgo-Thermit

Since thermite welds are essentially steel castings it has been proposed that a post weld normalizing heat treatment of the welds to refine the grain size should improve the mechanical properties and thereby increase service life. Heat treating tests which samples sections from welds have, in fact, shown an improvement in mechanical properties. However, the heat treatment of entire welds in track poses difficulties with regard to the through-thickness heating of the welds in a reproducible manner. Orgo-Thermit has developed an aluma-thermit process for normalizing a thermite rail weld which utilizes a reusable containment system for surrounding the entire weld with an aluma-thermit heating compound. The use of a fixed design of the containment system is a constant amount and formulation of the heating compound and a specified time of heating insures through thickness heating in a reproducible manner. An additional step of the process involves an a air quench of the rail head to achieve a specified hardness which is accomplished by a well-known technique. Mechanical property tests of full sized welds that were heat treated have shown significant improvement in the tensile strength, yield strength and ductility of the weld metal which translates into a significant improvement in the slow bend test results. Refinement of the weld metal grain size is the main reason for the improvement. The extent to which the heat treatment process will influence the service life of thermite welds is being determined by service tests at the FAST facility and at selected sites of several railroad companies.

Pandrol "C" Clip

Pandrol offers a variety of clips especially designed for use at track joints where joint bars interfere with standard Pandrol clips. Now Pandrol has come out with a "C" clip which has been specifically designed for use at most standard or insulated rail joints on wood or concrete ties. This low profile assembly consisting of 20 millimeter spring steel "C" clip and a pressed steel toe plate made from 7/16 inch steel provides vertical rail restraint and stabilizes track joints. This slide shows "C" clip, "C" plate and the optional snap-on insulater cap. Here are the "C" clip components assembled. The "C" clip is easily installed and is designed for right or left hand installations to avoid interference with track bolts. The "C" clip assembly can be designed for most rail sizes and is readily available in the commonly used rail sizes. This is the installed view of the Pandrol "C" clip assembly on a non-insulated joint along with a Pandrol tie plate and lock spike.

Fairmont Tamper TKO II

This is Fairmont Tamper's TKO II. In cooperation with several major railroads Fairmont Tamper has developed what they expect to be the next generation of tie remover/inserters, called the TKO II. This machine combines the functions of several machines into a single unit using advance hydraulics and computer controls. The primary objectives of the units are to improve efficiencies and lower installation costs by addressing material handling issues such as plate holding and tie placement. Rather than have the ties spotted along side the right-of-way relatively close to the individual tie to be replaced, the TKO II picks up the ties which have been placed on top of the rail and carries the ties with the machine to the exact location where the old tie is to be replaced. The unit also has the ability to hold the tie plates in place as the old tie is removed and the new tie is inserted. This is obviously a benefit, not only from the standpoint of efficiency of manpower and equipment, but the potential savings from the reduction of back injury due to manual plate handling. In order to combine this many functions into one machine and still maintain or improve overall production rates, it is necessary for the unit to perform several functions at one time. Shown here is the machine's ability to remove a tie while simultaneously positioning the new tie to be inserted. This multi-function capability would not have been possible years ago had the various functions been controlled and coordinated simply through the manual efforts of a human operator. Today, using microprocessors and advanced hydraulic control systems, one piece of equipment can be made to perform the functions of many.

Fairmont Tamper Mark IV Tamper

An overall view of the Mark IV tamper. The Mark IV tamper from Fairmont Tamper is designed for high production tamping, leveling and lining with the added versatility to tamp 100 percent of the switch area. All working functions are under the control of a Motorola 68,000 computer providing the most accurate results and inter-active operator interface. A large rear entry, fully enclosed, climatized cab is mounted on airbags, accessible from either side of the machine, via a rear platform equipped with conventional stair-type steps. The airbag suspension provides excellent ride comfort and added protection for the electronic components.

A unique sliding rear axle extends the wheel base for superior lifting capability, particularly in heavy switches and turnouts. The compuliner is Fairmont Tamper's latest lining option for on-site analyses of rail curvature. This slide shows the initial recorded data of the curve and superelevation, data showing desired superelevation and best fit for the curve. Best fit is the calculated fit for minimal track movement for maximum track correction. Data showing throws is on the top portion of the graph. The throws curve is an indication of the distance the computer calculates the track will be moved in inches, either uphill, plus, or downhill, minus. This curve is the result of a complex summation of the actual versus the best fit curves. It is meant to be a true indication of the total amount that the track will be moved if measured to an external reference from before the track is touched to the time after all tamping and lining is complete. Superthrows are the amount of superelevation being added at selected points.

Holland Tiescan

Tiescan, Inc. has been formed as a joint venture of Holland Company, Zeta Tech Associates, Inc., and DeBeer Applied Research Company to develop a tie inspection system for the railroad industry. Research for this project has been under the sponsorship of the Burlington Northern. The system relies on some compression and tangential waves that are transmitted through the wood. The speed of propagation and the degree of signal attenuation give a direct indication of a wood tie and the degree of its mechanical and environmental degradation.

The Tiescan system consists of a transmitter and receiver unit. The transmitter is placed on the gauge of the tie plate and the receiver on the field side. Sonic waves propagate under the tie plate, the area most susceptible to degradation in a wood tie. This inspection is done on both plates simultaneously at a speed of approximately two miles per hour. In addition to the hardware, a computer management program is available to better manage your tie programs. Contracting of services and/or purchasing of equipment will be ready in 1993. Marketing is presently being handled by Holland Company.

Holland 280 ton Super Puller

Holland's 280 ton Super Puller for closure and repair welds. The Holland Company has developed and sold to the Burlington Northern, two hi-rail Super Puller trucks that are used in conjunction with either a road-rail or rail bound flash butt mobile welder. The Super Puller is used to close the gap when welding welds in tension or compression. The Holland Super Puller can also be used to protect a newly made weld from external track forces. The Super Puller is computer controlled and interfaced with a K355 Holland welder head. These two units have 353 tons of force, 280 ton puller and a 72 ton welder head and can close a fourteen inch gap on wood or concrete ties. Today, you can install flash butt welds using this equipment rather than thermite field welds. Now repair welds and closure welds can be made using the K355 H head and Super Puller in the coldest weather.

We have a panel tomorrow, it's shown on your program, where we use four railroaders using both the Holland type of field in-track flash butt welding and the Plasser equipment. So you shouldn't miss that because the slides that the railroaders, who are the presenters, use are in much more detail and you'll hear a lot more about the equipment.

The two-vehicle system gives the welding gang 33 percent more production when compared to a single married rail bound welder and jack. This is achieved when doing repair welding. The first weld is not stressed and does not require the Super Puller. The second weld, the closure weld, is stressed. Therefore the Super Puller can be holding the stressed weld while the welder vehicle moves on to the next location and performs a non-stressed weld. This leapfrogging produces much greater productivity. Holland also has three 80 ton pullers and one 280 ton puller in its rail welding contracting fleet. So whether you use Holland's people and equipment through their contracting services, or your own crews using this equipment, you can reduce the number of thermite welds and return the track to its neutral rail temperature with the two-vehicle system of Holland Mobile Welder and Super Puller and obtain 33 per cent more productivity.

Plasser Ballast Distribution System

The Plasser Ballast Distribution System is a versatile high-capacity ballast reclaiming and distribution system that can provide tremendous savings by retrieving excess material from over-ballasted areas, loading the ballast, transporting it at speeds up to 50 miles per hour and re-distributing the material efficiently where it is not needed. Multiple conveyer transport cars can be easily incorporated into the system to provide additional carrying capacity as required.

Plasser K-355-SSW

The Plasser K-355-SSW mobile flash butt rail welding machine brings plant quality welding ability to the field. The machine's high travel speed and high production rate provide maximum utilization of increasingly shorter track availability times, reducing train delays. In joint elimination programs the K-355-SSW's rail pulling capability allows bent rail sections to be removed, the rail gap closed and the rail welded together in one process.

Plasser MTW-100 Catenary Maintenance Vehicle

The Plasser MTW-100 catenary maintenance vehicle was developed to provide a versatile machine for many uses of overhead maintenance work. The machine can be used not only for catenary maintenance and insulation but also for bridge work, signal work and other such duties. High travel speeds minimize train delays and complete on-board shop facilities and crew amenities save time and reduce logistics problems. These machines are custom-built to each customer's specific requirements.

Plasser Roadmaster 2000

The Plasser Roadmaster 2000 has been developed to provide complete switch and production tamping, track surfacing and track alignment using Plasser's latest technology. With the automatic geometry guidance system the machine corrects track geometry deficiencies with a high degree of accuracy. The Roadmaster 2000 unique double split tamping unit and combination switch production rail clamp provides optimum switch tamping capability as well as high production tamping rates.

Sperry Rail Service

This is the type test car that most of you think of with Sperry. Sperry presently maintains a fleet of 27 rail bored induction ultrasonic test cars. This is the only test car in the world that offers the dual test system of both induction and ultrasonics. Sperry presently has a fleet of six all ultrasonic hi-rail test vehicles, with three more under construction. The new cars will be ready for service in early 1993.

The next two slides show the detection control cabinets used on the induction ultrasonic test cars and the hi-rail test vehicles. Some of the changes made in recent years include the elimination of the counter tubes along with the addition of positive and negative gates and triple web gates in the zero degree channels. Additional logic has also been added to the 37 degree channels which is being displayed in analog form on the auxiliary dye tape. These changes have greatly enhanced Sperry's ability to detect web and longitudinal defects.

In addition to the improvements in the ultrasonic systems, logic has also been added to the C and D channels. With this change we can now operate at higher sensitivity levels which allows us to find detailed fractures in early stages of development, less than ten percent. A side benefit of this induction equipment change is the ability of the equipment to eliminate responses from insignificant running surface abnormalities such as slivers, flow flaking, etc., resulting in a cleaner record tape.

Herzog Ultrasonic High Speed Non-stop Test Cars

With fewer miles of track and higher density traffic, Herzog has expanded the development of its ultrasonic high speed non-stop test equipment. This equipment is capable of testing at 25 miles per hour and will be capable of 35 miles per hour in the near future. An average test day is 75 miles. The test data is displayed on an easy to read screen. The testing information is stored on a disk and, at the same time, is transmitted to a chase vehicle by a radio modem. A printer in the chase vehicle gives the location of the defect and approximate size and location in the rail section. The miniaturization of the electronics package allows for the test vehicle to be more versatile when mounted in a hi-rail vehicle versus a track-bound car.

One other consideration is the bulldog clamp, not shown here, when used with the test car. When the clamp is applied, the defect can remain in track for a period of five days before the defect is repaired. The bulldog clamp is FRA approved on the Burlington Northern and used on their Wyoming coal load.

Pandrol Jackson Technologies

The topics that Pandrol Jackson Technologies would like to highlight are recent significant PJT improvements in how we test with our RTS 300 system, our current North American standard, and a major step forward we are making with RTS 1000. In ultrasonically testing rail it is customary to use zero 45 degree and 70 degree beams. The 70 degree beam is the primary mode for testing for head defects. Most ultrasonic technology for rail has a tendency to lack sensitivity in areas close to the upper gauge and field corners. PJT now uses an array of three 70 degree crystals in place of the single 70 degree crystal which gives a much better view of the complete head of the rail. All are individually parallel fired and each has separate gain control. Hence the term, active 70s, is used to describe them. Field results have proven the superiority of this concept and it is now standard on all PJT test vehicles.

In recent times a major increase in population of defects known as field side vertical split heads have occurred predominantly in heavily worn rail. This is a rapidly developing fatigue-type defect which was hitherto very hard to detect. In response to requests from their customers, PJT developed a new type of side looker transducer which looks across the rail and sends its signal directly into the plane of such defects. The results, to date, have been excellent and the entire PJT contracting fleet is being retrofitted with this innovation which is equally effective with both new rail and head worn rail. This, in combination with the active 70s, means that 12 channels of information per rail are now being processed compared with the standard six used elsewhere in the industry.

By far the biggest news in RFD is the development of PJT's system RTS 1000 which is a high speed testing system with full pattern recognition. Many claims have been made over the year with respect to high speed rail testing and some even in regard to defect pattern recognition. The RTS 1000 system generally combines both these features with six channel wheel technology and will test in non-stop mode at speeds of 30 miles per hour. Five systems of this American developed technology have been sold to the People's Republic of China and another to Singapore Mass Transit. The pattern recognition feature will be further developed to make it applicable to hi-rail vehicles and thus truly introduce the concept of objective testing in the North American market.

Herzog Automated Ballast Car Doors

Herzog has automated the ballast doors on over 100 of their 100-ton ballast cars and provide them on a long-term lease basis to major railroads. The ballast door, in this case, an MK-style door has been automated. The doors are opened with a hand-held controller from a maximum distance of 500 feet. The doors have been completely reworked to accept this automation. Benefits derived from this design are many. Three major considerations are: removing the individuals from the dusty environment; reduction in injury exposure; and reduction in the work force from six or eight people to one or two individuals. The ability to distribute only the required amount of ballast in given locations can reduce the amount of time to regulate the material and extend the amount of ballast required per mile in some cases.

Herzog's Longitudinal Stress Measurement Vehicle

Herzog is in the final stages of developing its longitudinal stress measurement vehicle known as LSM. LSM will measure the stress-free temperature of rails at a speed of 25 miles per hour and also assemble rail height data. This is one more instrument that will provide needed information to determine when rails are in tension or compression and provide the highest quality ultrasonic rail test when used in combination. This slide shows the general arrangement of the LSM test car. The F350 chassis is equipped with a test carriage located on the bed of the crew cab vehicle. This slide illustrates the run light configuration of the test car. The car has a seating arrangement for two operators and a pilot. The rear seat contains the instrumentation console. The internal setup of the vehicle permits the driver to operate the mechanical controls, event markers and longitudinal location measuring equipment. The pilot position is equipped with a radio. The chief operator monitors the LSM survey equipment. Stress conditions measured above or below the predetermined temperature threshold are downloaded to the on-line printer located between the front seating. This slide shows the layout of programmable controller and the computer system that controls the input and output and handles the LSM data. The right hand VGA monitor monitors the stress free temperature and rail height measurement with distance on a scrolling XY multi-data format. The left hand screen is a touch sensitive control screen that monitors the measuring system. Here, the system is operating at 25 miles an hour with the carriage towed behind the hi-rail. When traveling the sensors are lifted from the rails and the carriage and can be towed at higher speeds. This is a rear view of the test mode showing the rail marking unit and roller sensors that generate the stress proportional signals. The lead roller measures the rail height for cross sectional area calculations.

This completes the slides but hold your massive applause. We have one member of REMSA whose slides were lost in our great U.S. mail system and so they brought me today a training video that they use for the UP Railroad. It's from Hogan Manufacturing Company and Hogan has developed a high speed rail drill that I'll step down here for a moment and turn on so we'll get to look at our last presentation of a high-speed rail drill.

(Whereupon there was a video presentation)

Mr. Terrill: Their slides really did get lost. I know they were sent and that's why we allowed the video presentation. That, plus the fact that when I wrote to my postmaster he told me the reason that mail in the United States costs 29 cents. He says four cents goes to Denny Sullivan at Amtrak for transportation and 25 cents is for storage and inventory. (Laughter) That was from the postmaster.

That concludes the slides and the presentation and as I said before these are the words of the suppliers and they are sitting here just hoping that you will ask all kinds of difficult technical questions so they can make some lunch arrangements. So, please, if you have any questions on any of the machines let's hear them now. Certainly there are some questions out here, I think I have five minutes left so you don't have to ask too many. I have ten minutes. No one in this vast audience. How about some suppliers asking about some of the competitive patent rights and stuff like that. (Laughter) No questions out there. Okay, then I guess I'm all done. Thank you very much. (Applause)

President Walbrun: Thank you very much, Vinnie. For those of you who received the conference feedback forms I would like you to pay particular attention, the latest topic that you just saw was concerning a number of new products that are available in the rail market. This is a departure from our previous conferences and we feel that this added a number of advantages to the program that you are already attending. If you feel the same way or if you feel otherwise please fill out the forms and let us know how this change in our format worked.

As of right now we have a total of 540 registered conference attendees with 98 spouses for a total of 638, making this a very good turnout.

Our next presentation is entitled "Plugging the Chicago Freight Tunnel Leak". For those of you who are unaware, there is a network under a number of Chicago city streets of small freight tunnels that travel throughout the city. This presentation will be presented by Jim Kenny, vice president strategic planning with Kenny Construction. Jim started with Kenny at age 16 as a laborer and worked every summer until he finished Bradley University. He worked under the master craftsmen who are an integral part of the company his grandfather founded in the 1920s. As a third generation contractor Jim followed his brothers into the company and carved out a niche – strategic planning and business development. As a heavy industrial contractor, Jim targets specific bridge, highway and tunnel projects throughout the country. To date he has been involved in over $1 billion worth of heavy industrial projects spanning from the Calumet Deep Tunnel project to the Los Angeles Red Line Transit project to the Dan Ryan Expressway project. In addition to his involvement in the construction industry, Jim finds time to be involved in public and community service. Governor Jim Edgar appointed him to the Metropolitan Pier and Exposition Authority Board. He is also on the expansion committee for both Navy Pier and McCormick Place. President Bush appointed Jim to serve on the National Corporation for Housing Partnerships. After Senate confirmation, Jim joined the Board's other six members whose mission is to provide housing for low income families across the country. Recently Jim was selected to join the Board of Directors of the Illinois Ambassadors. He is also a member of the boards of both the Illinois Roadbuilders and the American Underground Space Association. During the Chicago flood project, as a part of the disaster team, Jim was the liaison to the various local, state and federal governments and agencies that were involved in the flood project. Please join me in welcoming Mr. Jim Kenny. (Applause)

PLUGGING THE CHICAGO FREIGHT TUNNEL LEAK

James C. Kenny

Kenny Construction Company

Good morning. What I would like to do today is to give you a brief history of our company and then get into the great Chicago flood.

Kenny Construction Company has been in operation for over 65 years. We are a major heavy civil contractor that has performed every type of building construction and heavy construction at one time in our life. Basically, the types of projects we build are all across the country and into Canada. Internationally we are known for our tunneling capabilities and have sent engineers and consultants to consult on projects in England, Italy, China and currently we are looking at a project in Japan. The following slides show some of our recent projects.

(Whereupon there was a brief slide presentation)

Now I would like to get into the great Chicago flood. It was about 7:40 in the morning on April 13, 1992, when I received a phone call from a commissioner of sewers in the City of Chicago. She had asked my secretary if she could speak to one of the Kennys in the office. Then she gave a brief description of the situation in downtown Chicago. At that time they were not sure exactly what they had at that time of the morning. Anyway I walked into my brother John's office and said, "John, you should take this call. The city sounds like they need some help and you would be the perfect man to handle this." (Laughter) As it turned out, he was the perfect man to handle the situation.

We both started formulating game plans in our mind as to how we would attack the problem. We had not been to the site yet. John left the office and was immediately on the car phone calling a lot of our underground division engineers to meet him at the site and at city hall. I stayed at the office and started calling all our trucks that had been cancelled for that day back into the yard to get ready for the possibility of moving equipment, materials, etc. down to the site as soon as we knew what we would need.

When you get into one of these things and begin a game plan for something you're not sure of, you have a lot of misconceptions in your mind of what you're going to meet and see. John had set in his mind that his mission was to stop the water from flowing into the freight tunnels from the Chicago River. That was his goal. He said his underlying objective, which was kind of interesting as we got into it, was that he wanted to see that nobody was hurt or nothing damaged. Over a million people left the city. No one was hurt; there was no panic. John accomplished that underlying objective. We ended up working seven days a week for several weeks and we are still working to this day. We have not had one accident on the job to this date.

This is a map which shows where the tunnels run underneath the City of Chicago. This was a very futuristic approach to a city. There are over 50 miles of tunnels that are underneath the city and connect to a lot of the buildings. Some of the original buildings were demolished and new buildings were put up in their place. These tunnels run all over the city. Back in the 1900s they ran coal, freight and things like that through these tunnels and they went to places like Marshall Field's and other big stores. Disney World in Florida operates on the same type of concept today. At Disney World in Florida there are tunnels running underneath the whole park where they move millions of pounds of coins, supplies, personnel, garbage, all sorts of things, every day. So back a 100 years ago, the city fathers here had a great idea.

After the remedial work we are doing now in the tunnels, they will be kept and used. After this occurrence, some people thought the city should abandon the tunnels and forget them. However, when you have a major investment in something and when you get into underground work which is where we spend most of our life, you get into the life cycle of an underground project, and it really far exceeds that of many of the projects that stand out in the open air and up in the air. So the the city formed a user's group of cable television people, fiber optics people, our power company, and the telephone companies. They wanted to use these tunnels for the future and come up with a game plan to shut off at the river crossings any possibility of the freight tunnels flooding again. That was part of the game plan.

As as you can see it's an interesting approach. When we first got into this situation, the easiest way to explain to the city people and the non-technical people was with a straw. So we took a straw and said this is the freight tunnel; the river runs across it. Our concept was to squeeze the straw and stop the river from flowing into the rest of the city. We received over 600 solutions sent to us by phone, faxes and Federal Express. They ranged from blowing the tunnels up with dynamite to filling the river with jello. (Laughter) We responded to that fax with, "What flavor?" (Laughter)

We worked the first day and night without seeing the reports in the newspapers, or on television, and we didn't understand the magnitude of where this was possibly heading. When the everyday things like water, power, electricity, elevators, computers, and escalators are shut off, that does cause major problems and that's what was developing here. As the flooding went further into the tunnel, it was shutting the city down. So as we sat there the first night trying to plug that hole in the river by squeezing the tunnels, as we called it, we began to see the magnitude of the problem. What we didn't realize is the microscope we would be under as work progressed.

As we got into this disaster, little offshoots started happening right away. This is a portion of the Kennedy Expressway called Hubbard's Cave. The Kennedy Expressway is a major arterial road in Chicago that runs through and around the city. There is a drainage tunnel underneath it that started to collapse from pressure because the freight tunnel crossed it at one section horizontally and water was coming in.

All in all, we ended up working in four different locations. Everybody thought we were just working at the Kinzie Street site. We had teams of engineers over at the Metropolitan Water Sanitary District formulating game plans to drain the tunnels from there into the Deep Tunnel System which are the major tunnels that I described before that run underneath the city. We had people from the Illinois Department of Transportation working on Hubbard's Cave. We were hired by the CTA to go into the subway tunnels to set up a chemical grouting program and epoxy fill some of the leaking joints. There was a lot of horizontal pressure from water leaking in where their tunnels ran across the freight tunnels. Many sections of the CTA tunnels looked like car washes.

The Mayor of Chicago came to the site the morning of the catastrophe. He called the fire and police commissioners and the various department heads together and informed them that John would be in charge of the project. I don't mean to boast but the idea of setting one man who had the technical expertise and know-how to solve the problem in charge of a catastrophe like that was a great decision.

Another decision the Mayor made, which I liked, was to set up a command center in an old library. From that command center, the Mayor called in all the governmental agencies, the Illinois Emergency Management Group, the CTA, the Illinois Department of Transportation, and the Army Corps of Engineers, who played a large role. They were all in one building so that the decision-making process in this was obtainable by having people close by. He would have meetings on one situation and be able to move to another table to meet with people who were decision-makers and who could give you an idea of what was needed. Basically, city hall wanted a hero to come out of this situation and solve their problem. Superman wasn't around so they ended up turning to my brother John who did an excellent job. He kept a level head and was very down to earth and not egotistical and as he said, "What we need here are not titles and egos, but people working together as a team." Everybody bought into that concept because we knew we had a major problem to solve. John was the leader in that approach and that's why we think it worked.

We had a little bit of luck on this job. We didn't have any lawyers show up. (Laughter) (Applause) I had a phone call from a fellow in New York City who asked if he could come down and take a look and see what we had done. I told him that would be great, come on. As he looked at our operation and how we were doing, he brought up the lawyer situation. He said that in New York they probably couldn't have done this. He said, "We would have had the lawyers down there, we would have had the unions down there and the mob would have been down there trying to make some deals. I don't know how you kept people like that out of here." We were fortunate that we were able to do our job and not have to worry about the litigation.

Red tape was a major part of this catastrophe. The Army Corps of Engineers was great in that they realized that some of their own intricacies couldn't work. They told us that one letter from the Army Corps of Engineers would take 22 signatures and 30 days. They, in the meantime, knew that that wouldn't work here and they worked with us to change the ideas and concepts that they perform under so we would be able to cut some red tape to achieve the goals we had all set. They showed up on the project after about a week into it and they were great people. We had one fellow in particular who visited us the first night on the bridge with a portable phone. He told us that anything we needed would be there as quickly as possible.

At the bridge site we had a masonry brick wall that ran up about 50 feet tall. It was the middle of the night when we started to pound the street to start the first caisson into the tunnel and the owner came out and said he had a problem, the wall was moving. So we needed structural engineers late at night and this fellow with the portable phone who had tagged along with us got them down there in minutes. As I said, these little offshoots began to develop that had to be handled immediately. It was incredible. I have great faith now that if we put public and private together and work together we can accomplish great things.

The Police Department was excellent. They did a lot. It was the police commissioner's first day on the job, he was just appointed that morning. It was baptism by fire and he did an excellent job.

The Fire Department also did an excellent job. Chief Ray Orosco is an extremely talented man. He put his game plan into action that morning when they decided to evacuate the city. Over a million people were evacuated. There was no disturbance, no panic. It went very smoothly. One of the things that I attribute that to is in a disaster like this, there is no destruction visible to the human eye like you see in a hurricane, tornado or a flood. In this situation the disaster occurred all underground. People didn't see what was happening and I think that attributed a lot to why there wasn't any panic.

The Army Corps of Engineers played a large role in this situation and were very good people to deal with and work with. Our sub-contractors and the suppliers bought into the team concept and effort. We couldn't have done this alone, it took the cooperation of many and we thank them for it.

This is where it happened. As you can see underneath the two pile clusters is the freight tunnel at Kinzie Street where the breach occurred. What made this very tough technically was the breach was underneath the piles. To get to that at night and try to shut that off, was very tough. We pumped a lot of concrete and different things to bridge up over the freight tunnel to seal it. In this slide you can see a diagram of what was there. In the dark we couldn't see it. We were only imagining where we thought the hole was. Later we understood the hole was about the size of a car. The work we did Monday night of pumping concrete and trying to bridge over the top of that got it down to about the size of a basketball, so we did have an effect. But you can see the complexity of the situation of how the Chicago River got into the freight tunnels which connect throughout the city.

We brought in some high tech equipment. We had a type of mini-submarine that operated on sonar and video and that was our eyes and ears on the project for the first couple of days to tell us what we had in the river. It would go down by the breach and take a look through sonar and video to give us an idea of what we had. Later on we had a gentleman whose task throughout the flood was to be in charge of the entire river. He would go up and down the river in a boat that did soundings at all the other tunnel crossings where we knew the freight tunnels existed to see that no other problems were developing.

This is an aerial view of the site. The red is the freight tunnels as they march off into wyes. You can see it was not just one spot where we needed to squeeze the tunnel. We had a number of areas to shut off from the flood. The two peach colored things are the pile clusters where it occurred. The purple looking thing is the river flowing around them.

We set up a drilling company to drill down and locate the top of the freight tunnels. Then we brought on the caisson rigs to drill the casings and sink the casings down and grout them into the top of the freight tunnel.

The yellow section is where the first shaft was. Our game plan was to go down that access which was really into the east part. That headed east to the city and was a major area to shut off as fast as we could. The others connected at different parts heading west of the city, which is off to your left. Our first game plan was to set up six of these shafts. Eventually we ended up with about ten of these shafts. We put in what we call bulkheads which is just a mass of concrete to stop the water at these points in the freight tunnel.

One of the things we didn't know about is the amount of muck that was flowing in with the water. The power of water is tremendous. It was amazing how much muck came in, how deep it was and and how it started to harden in the bottom of the freight tunnels. When we first sent a diver down, the flow of the water was anywhere from 40 feet a second to a 100 feet a second and it was incredible. What happened was all the people in the city were using their pumps to dewater their basements and that was creating a big suction of pulling water from the river so we couldn't get a diver in. We came up with the concept of putting sandbags down, as you see in the left shaft. After we dewatered the tunnels you could see the sandbags did do the job. It was just a simple approach that worked for us as we continued with the project.

The divers played an integral role. They were very brave men going into conditions that were unknown. As I said, the flow of the river and things like that were very critical. We ended up putting a video camera and a light on top of the diver's helmets. They were also connected by audio. One of the amazing things, once the divers got down there, as you can see through the window of this trailer, we could see better than they could. They moved by their hands. In fact all the measurements we took were by hand and we would get the divers, who were excellent in telling directions, what situation faced us. They were our second eyes and ears, actually being in the freight tunnel. After a diver would come back up we would debrief him. Every diver told exactly what they saw, what they thought we needed, how the casing was set in the hole, so we could go on to the next step.

This is where we get into it, where you see the two shafts, the one with the sandbags on the right and the second one on the left. What we did to get the muck out of the bottom of the freight tunnel was basically air lift it out with a sucker. As we got down to the bottom of the freight tunnel we wanted to get a good seal when we put in the concrete and we actually gave the divers brooms to take down on their last dive to clean the floor of the tunnel so we could get a good seal with the concrete bulkheads. As you can see there by the diagram we poured concrete in about a quarter of the way up and let it set for about four hours. Then we continued to pour all the way up trimming it up through the caisson. We put an H-beam in the casing all the way down to the bottom to help set in some type of structural capability of that caisson so it would not move.

Basically this is what the bulkheads look like today. Our duty for the city today is to go in at all the river crossings and install these bulkheads to further prevent any more flooding that might occur. A number of the holes you see in the concrete are some that we're plugging in so that they can be used to bring the utilities across the river for use in the freight tunnels in the future.

We then turned to the pumping and dewatering of these tunnels which ended up being fairly critical because we didn't want the tunnels dewatered at too rapid a rate since that might cause the existing freight tunnels to fail. The concept that worked was a good one. It ended up that we didn't have to connect through the Deep Tunnel, drilling through rock. What we did was pump the water up from the freight tunnel across land and down into the Deep Tunnel. The Deep Tunnel is these large 30 foot diameter tunnels that store water runoff that I described before.

The media plays a large role in a catastrophe like this. We had four press conferences a day in the first and second weeks and that gradually went down. The media is a great tool for communication to the outside world and the public. We had phone calls from all over the world, plus newspapers, magazines. Popular Mechanics wanted to do a story on the job. Wherever we went in the city, they followed. They wanted to see and get any reaction or updated news and they were all fighting. It's almost like when we got into the thing like the Desert Storm Gulf War that we all want instantaneous news and access as to exactly what's happening minute by minute. I think we will see that happen with whatever future disasters that occur in the future.

As we get down to the end, the project ended up being one-third construction, one-third engineering, setting up a workable game plan and making sure you followed that game plan from day one to the end and the last one-third is government; because government played a large role in who's going to pay for this and helping us cut the red tape. They played a critical role in helping make some major decisions and to the success of this project.

This is a slide taken on one of the last nights on top of the bridge at Kinzie Street. We took great pride in looking at this picture. It showed that at the end of the project we did get some lights back on in the city and the city started operating again, bridges were moving, subway trains were going, and so on. We thought it was a great project. We did enjoy what we were doing. In those types of things you don't think you can, but you can as you get going and you know you are going to be a success and get something accomplished.

I think one of the things Kenny Construction got out of this project is that there is no limit as to what you can do in a situation like this if you don't care who gets the credit. I think what John brought to the project was his willingness to pass the credit along to all the subcontractors and the Mayor and everyone. It was a team effort. Everyone involved contributed to help solve this problem. As I said, government and private industry showed us that they can work together to solve problems. It gives me great faith to say that for the future and for us in the nineties with all the problems we will face with the infrastructure, that government and private business can work together to accomplish our task.

Thank you for your time and I'll be happy to answer any questions I can for you. (Applause)

Member: You mentioned that the Fire Department had a plan and they put it in place. Was that a pre-plan, a contingency plan for tunnel problems?

Mr. Kenny: That was for the evacuation of the city. When you have to evacuate a million people or more the fire department already has formulated plans. The Fire Commissioner, as I said, did an excellent job of following through with the plan. It was terrific. Everyone evacuated the city without panicking. They gave free train rides out of the city. No one had to pay on the trains or buses. It was very well done.

Member: I'm sure it was in the news at the time but I don't recall, how long that part of the city shut down before they could come back and get into their businesses and this type of thing?

Mr. Kenny: Well, it was on a building by building basis. There were roughly over 30 major buildings that shut down operations. We had law firms moving, carrying computers downstairs, it was bizarre stuff. As I said, as the project gradually went on to when you got an area where you could work in, Commonwealth Edison would restore power on an individual basis. It was a matter of going in and working with the individual buildings in getting the water out and the power turned back on. The water went down gradually over days and weeks. So it was a long process. A few of them got back on line right away. The subway tunnels took a few days and a few weeks to get back on and make sure they were right.

If there are no further questions, thank you very much. (Applause)

President Hill: Thank you very much, Mr. Kenny. That was very informative. I live here in the area, and watching what the news presented and seeing your explanation, the coverage was very good from a media standpoint but your presentation cleared it up as to what exactly was going on there. I can understand what you had to go through fighting to get the right story out.

I would like to thank all of this morning's speakers for taking the time to be with us. Before we adjourn this morning's joint session, I would like to ask you all to pick up a special committee report sheet. B&B is yellow and Roadmasters is green. Fill it out and turn it in at the registration desk. These special subject cards will be the basis for the 1993 program in Denver.

The Roadmasters' session will reconvene back in this room at 1:30 p.m. The B&B will meet at 1:30 in the Cotillion Ballroom just down the hall from here. This session is now adjourned.

MONDAY AFTERNOON SESSION

September 21, 1992

Mark Walbrun

President Walbrun: Welcome to the first session of the 1992 B&B annual conference. Our registration is very encouraging with 74 B&B members, 131 Roadmaster members, 261 suppliers, 95 guests and 98 spouses, for a grand total of 659.

This conference culminates eight years of my being on the Board of Directors of the B&B Association. I have worked with some of the best people in the rail industry who have been involved in the organization and it really raised my perceptions as to the capability of the industry. There is no way we can fail with the people we have.

In eight years the B&B organization has rewritten our constitution, bringing it up to date. We have instituted seminars to educate our members on various subjects. To date we have held seminars on railroad contracts and bridge inspections. Two additional seminars on bridge inspection are scheduled for 1993. You will be receiving information on that later this year.

We have redone the operations of the entire organization, we changed finance systems, we've gone from a period of having almost no money to a situation where we can now launch activities and be fairly well assured that if we make any mistakes or fail, we're not going to send the organizaton plummeting down into nothing.

I've enjoyed the past eight years and look forward to continuing my involvement with the Association.

I'll now turn the program to our program chairman, Don Steele.

Mr. Steele: Thanks, Mark. Our first special feature is titled "Quality Welding, Welding Procedures and Safe Practices". The presentation is to be given by Latham Mortensen, better known as Mort, who is an instructor at the Central Community College at Hastings, Nebraska. Central College is a two year vocational-technical college. Enrollment for 1991-

1992 was 32,000 students. Last year more than 130 companies participated in some 250 training programs. Union Pacific has, over the past five years, utilized this school for certifying its welders.

Mort started the welding program at Hastings in 1967 after working 10 years in the industry for several organizations. He has coordinated and implemented welder training for several industries and utility companies. He has been an active member of the American Welding Society for 25 years and has served two years with the American Society Committee for the B3.0 Welding Procedure and Performance Qualification Standard. Mort has served as a jury member for the James F. Lincoln National Welding Contest, received the Faculty Member award from the Nebraska Community College Trustees in 1986 and the 1987 Western Region Faculty Member Award from the Association of Community College Trustees in Calgary, Canada.

Knowing Mort's capabilities, it gives me pleasure in having him present this feature.

QUALITY WELDING, WELDING PROCEDURES AND SAFE PRACTICES

Latham Mortensen

Central Community College
Hastings, Nebraska

Quality welding involves more than a skilled individual depositing weld metal at a designated location and in the proper amounts. It involves commitment to a team effort by every individual involved, from the design engineer to the welder. Unfortunately, such team effort is seldom recognized, and communication between individuals often fails.

Everyone executes job responsibilities with a lot better results if everyone knows the rules, why the rules exist, and how to interpret the rules. These rules may be employer policy; safety regulations and procedures as identified by the employer; or welding and inspection procedures, all of which may have been adopted from other codes or standards. It is important that everyone involved with a welding activity knows what his or her responsibility is and how individual work affects the total project. There are many facets of a project and all are very important. This paper will be touching on (1) welding and testing procedures; (2) weld inspection; and (3) safety in the welding environment.

Welding Procedure/Specification

The development of acceptable welding procedures is the first and most important step in producing a quality product. There are a lot of variables that must be considered when developing welding procedure specifications, but among the most important is the welding process to be used. The range of base materials to be used, the filler materials to be used, and the joint designs that will be used in the project are also required factors in the development of welding procedure specifications (WPS).

A code or standard must be selected which will provide a guide for the development of the welding procedure specification (WPS). The most commonly accepted standard in the construction industry is American Welding Society Structural Steel code D1.1-92. This standard becomes the guide that will be used from the joint design on the project engineer's layout to the welding inspector and his responsibilities after the weldment has been completed. It is important that everyone involved in the project realizes that compliance with this standard is the reason why the fabrication is completed under strict supervision.

This code (AWS D1.1-92) requires an identification of an acceptable welding process. This process would probably be either the Shielded Metal Arc or Flux Cord Arc welding process. These processes would be selected because of their portability, no welding position restriction, successful use on a variety of base materials, satisfactory deposition rates, and because they are user friendly.

Joint design usage is important because there are two categories of joints possible, either pre-qualified or not pre-qualified. If the joint is pre-qualified as identified in the D1.1 code, the joint could be used without performing the joint welding procedure qualification tests. This pre-qualification includes the joint geometry groups of base materials that may be used and the welding process and the filler materials that may be used. These joints have been previously tested and used by the industry.

If the joint details depart from the prequalified joints, the details of the joint must be approved by engineering. The producer of the joint must demonstrate to engineering that the joint is adequate before approval or acceptance is granted. This is achieved by following the procedures outlined in the code for testing. The types of tests and their purposes are as follows:

For groove welds:

1. Reduced section tension test (for tensile strength)
2. Root-bend test (for soundness)
3. Face-bend test (for soundness)
4. Side-bend test (for soundness)
5. Longitudinal face, root-bend test (for soundness)

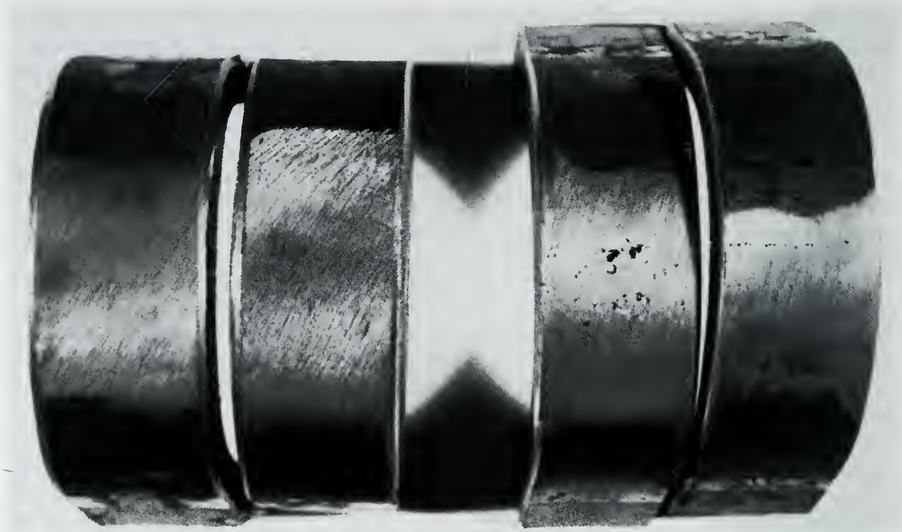
For fillet welds:

1. Macrotech test (for soundness and fusion)
2. Side-bend test (for soundness)
3. All weld metal test (for mechanical properties)

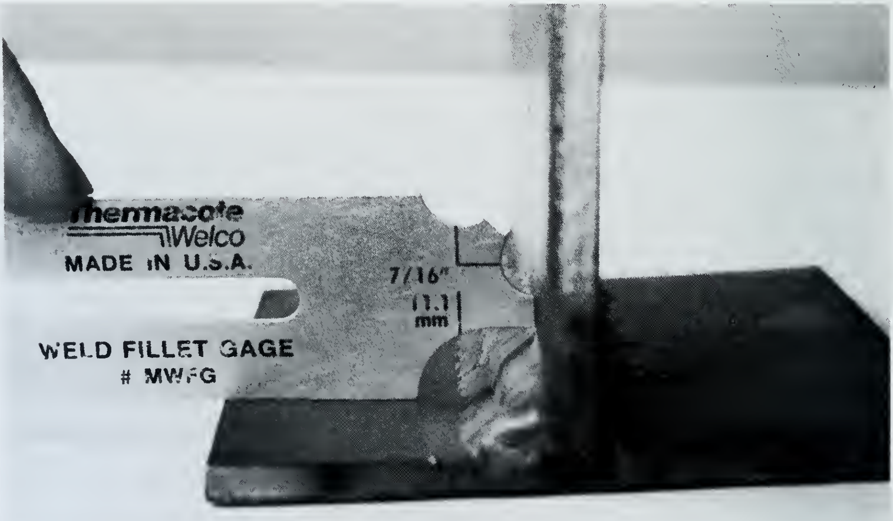
The base materials must be identified so that the WPS (Welding Procedure Specification) will cover all materials used. If materials of different groups are used, additional testing will be required. All base materials are listed by the groups. These groups are based on the properties of the material. The AWS D1.1-92 code identifies group by: (1) American Society of Testing Materials (ASTM) number and grade, (2) minimum yield point/strength, (3) tensile range. If changes are made in the base material from one group to another, new welding procedures must be developed, and the welders must be requalified.

Filler material selected (flux cord or shielded metal arc electrodes) must be selected, and that material must be compatible with the base material. The size of the filler material must also be established with consideration for welding position deposit. The Flux Cord process would probably be most successful with an E71T1 or a E81T1-NiL electrode with a 1/16 or 5/64 diameter. If the Shielded Metal Arc Welding process was chosen, an E7018 or E8018-C3 electrode may be selected. These are both low hydrogen welding techniques and will provide adequate tensile strength. If the flux cord welding process is selected, the type and flow rate of the shielding gas, if any, must also be specified.

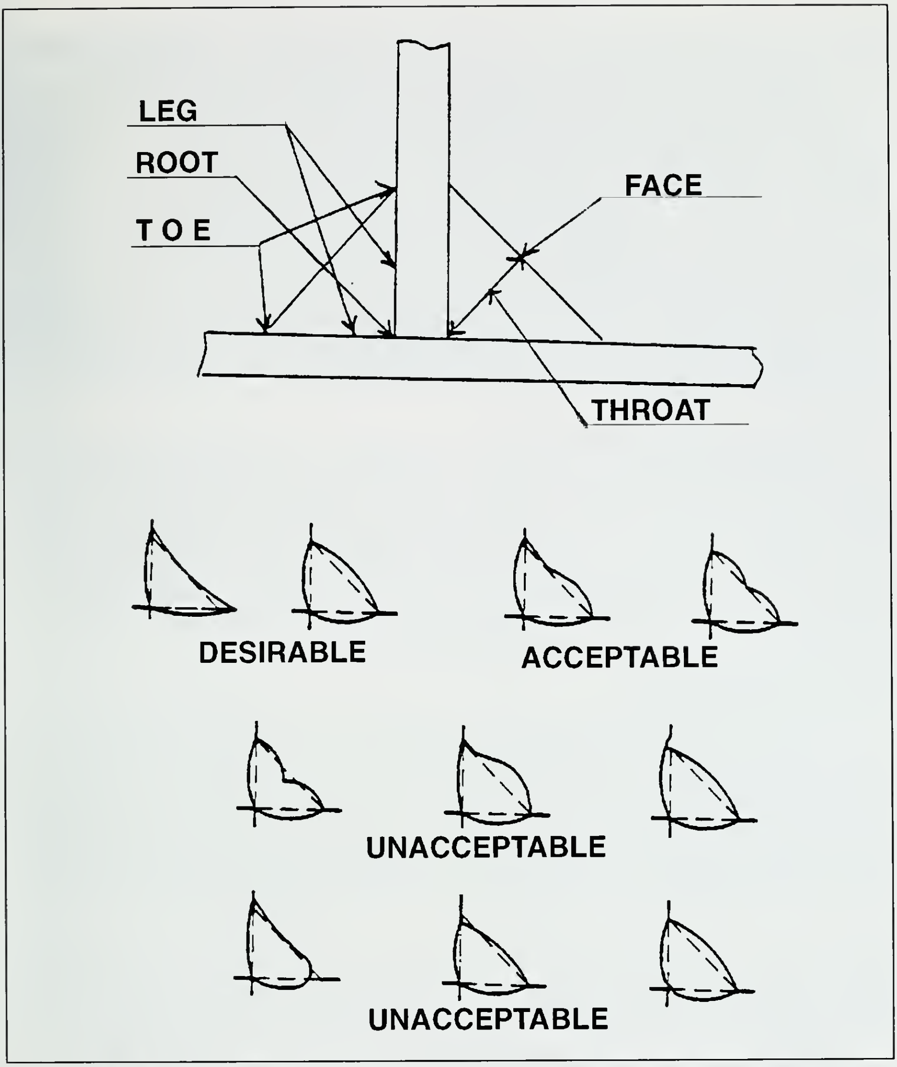
Preheat and postheat treatment, if necessary, must be documented including interpass temperatures. On some base materials it is important to maintain certain temperatures during the welding process. The interpass temperature is the temperature that must be maintained between passes on the base material near the welding zone. This may be more critical if



Root and Face Bends of Two Test Plates, Left – Acceptable, Right – Not Acceptable.



Measuring 7/16" Fillet Weld Size



The above drawings identify the nomenclature of a fillet weld and examples of fillet deposits. The desirable fillet welds are very uniform, one having a slight convex face and the other a slight concave face. Neither of these have any depression below the recommended fillet size. The acceptable fillet welds show a little irregularity on the face but still have no depressions below the required fillet size or geometry. The first unacceptable fillet illustrates a depression in the center of the fillet face or lack of throat distance. This causes a lack of weld metal in meeting the requirement of the designated fillet size. The second fillet is showing excessive build up on the face. The code allows for only 1/8" build up above required deposit. The next fillet has excessive under cut at the top toe of the weld face. Overlapping is shown next on the bottom toe of the face. This is a good indicator of a cold weld and will probably not have good fusion. The fifth fillet shows a lack of leg length on the vertical leg. There is just not enough weld to meet the fillet requirements. The last shows a lack of fusion in the root. This is the hardest defect to identify. It is found most of the time with Ultra sonic or x-ray testing.

working in cold temperatures. Even on A36 steel, a weld deposited on cold metal is susceptible to cracking in the center of the weld and could also crack in the heat-affected zone.

The electrical characteristics are most often determined by the filler material being used. The use of direct current, reverse polarity will always achieve the deeper penetration providing there is metal being transferred across the arc. There is metal transferring across the arc using either the flux cord or shielded metal arc welding processes. The deposit sequence should be established in the welding procedure specification. This would include both the bead sequences and the amount of weld deposit per pass on a multi-pass weldment. The electrical stick-out distance (the distance the filler material extends beyond the end of the contact tube) must be listed and enforced very closely when the flux cord arc welding process is used. The filler material or electrode extending from the contact tip to the work adds resistance to the welding circuit; therefore, a substantial drop in the welding current (amperage) will occur as the stick-out length is increased. This condition will cause susceptibility to poor penetration and overlapping of the weld metal to the base metal.

Welding Procedure Qualification

The specific information listed in the WPS includes size and classification of filler material, the electrical characteristics, electrode feed rate if flux cord welding is used, the gun travel speed if the welding is achieved automatically, and the shielding gas if any. The welding procedure qualification (WPO) is a document produced by the company or contractor which provides proof that by welding under the conditions listed in the WPS a good weldment can be achieved. This weldment must be tested by tensile test, guided bend tests, and visual inspection. The weld appearance must have some degree of uniformity. It should not have excessive undercut, excessive build-up, or overlapping.

Welder Qualification

The WPS and the WPO have been developed and are on file in the engineering office. The welders now have proven parameters by which to qualify. The welder is required to weld two coupons with single vee groove butt welds with 45 degree included angles in the vertical and overhead positions. At the successful completion of the testing of these welded coupons, the operator is then qualified for groove and fillet welds in all positions. If a backing strip is used for the vee groove weld, the welder is not qualified to weld on any open groove welds. The test requirements are as follows: (1) no more than one-eighth inch face reinforcement, (2) no more than one-eighth inch undercut, (3) no more than one-eighth inch incomplete penetration, (4) no more than one-eighth inch slag or gas pocket, (5) no more than one-eighth inch or one-half the thickness of the metal being welded on is the allowable accumulation of discontinuities that measure 1/32 inch or more, but less than one-eighth inch. If these criteria are met, the welder is then qualified. This is a very standard test and is used to a great extent in the industry.

Once the welder has successfully completed the welding qualification requirements, that person is qualified to weld on the project and may continue to weld unless that welder's skill is questioned by a supervisor and a retest may be required. Welders must also requalify when six months have passed since they last used the welding process specified during the qualification. These requirements are for the protection of the company. Physically, people change; eyesight changes, coordination changes, and other physical problems may impair the welder's motor skills. The standard allowing for retesting protects the company from having unqualified welders on the job. When product liability is at stake, everyone has a responsibility. A good welder should make each weld as if it were another test.

Weld Inspection

The inspection of the completed weld is an important aspect of the total project. The welding is inspected most of the time by a welding inspector whose responsibilities are for quality control of the welding and for keeping proper records. The welding may also be inspected by the gang foreman and/or the field supervisor or, in limited cases, by the welder doing the welding. The welders always inspect their own work and procedures, and in most cases on the railroad bridge gangs the welder is the only inspector used. Regardless of who is doing the inspection, it should be carried out in a systematic order.

First, the weld inspection must proceed with what is commonly called the procedure inspection. This inspection involves three phases: (1) before welding, (2) during welding, and (3) after welding. The before welding inspection would include base material and filler material, chemical analysis and properties. Base metal defects include lamination and cracks, surface irregularities, and flatness. The joint fit-up would include edge preparation (root face and beveling) dimensions, cleanliness, root opening (if any), a tacking and backing when required.

During the welding it is important to monitor preheat and interpass temperatures, to inspect the root pass, to observe cleaning between passes, and to watch workmanship of the welded joint. The voltage, amperage, wire feed speed, electrical stickout, and arc length should be checked while an arc is established. All of these variables must be in agreement with WPS. After welding, there may or may not be a need for post-weld heat treatment.

After the weld has been completed, an acceptance inspection must be made. This will include the method of cleaning for inspection and the selection of the nondestructive testing procedures to be used. Most important is the visual inspection. Using this testing procedure, the inspector is concentrating on the surface appearance of the weld and the conformity of the welds with the drawings. The fillet gauge is a necessary inspection tool to determine fillet size. Most fillet welds are measured by leg length. The throat of the fillet may also be measured, but that measurement is not as widely used. Magnetic particle, liquid penetrant, radiography and ultrasonic are other test methods that may be used which will assist in determining the soundness of the weld. When a weld is being inspected, It must be done with information available from the design intent of that weld. That is normally done with the use of welding symbols on the fabrication blue print. This information constitutes the weld profile. The code specifies the bead shapes that are acceptable and those that are not. To be in compliance with the code, the bead profile must meet the specifications based on weld size given on the print.

Safety

Nothing is worth doing unless it is done safely. Safety is always a must, and for welders it can be looked at in three areas: equipment safety, personal safety, and environmental safety. If the equipment isn't safe, people may be injured. If personal safety is ignored, people may be injured. If the environment is not safe, others may be injured.

When considering equipment safety on the job, the oxyacetylene cutting equipment must have top consideration. The hoses, regulators, tips and torches must be in good condition. The acetylene cylinder must never be in any position other than vertical. The reason for this is that the liquid acetone which fills the cylinder must not come in contact with the cylinder valve. If the liquid acetone were to come in contact with the cylinder valve, the acetone would be allowed to pass through the valve into the regulator and hoses when the cylinder valve was opened. This will happen even when the cylinder is set back to the vertical position. The acetone in the regulator and in the hoses will cause damage to both. Any petroleum by-product or product which may come into contact with oxygen under pressure will explode. Therefore, when handling the oxygen equipment, care must be taken never to get any grease or oil or other petroleum material on the fittings on the oxygen line. Otherwise a violent explosion could occur.

Cables carrying current to and from the power supply must be in good repair. If there are cut cables or loose connections, the electrode holder will get hot while welding, and if large currents are used, the cable may overheat and burn up in the cut area. Good, approved extension connections must be used at all times. All electrode holders and terminal connections must be insulated. OSHA safety and health standards should be used as required safety policies.

Scaffolding may also be considered equipment. When scaffolding is required, it must be safely constructed and meet OSHA standards.

Summary

Quality work is a must in the welding industry. With fewer problems in the construction and service of railroad facilities and structures come fewer problems with outside agencies dictating procedures, techniques, and other details to the owners. This makes it easier for everyone. This quality is best obtained by disseminating information. There are many factors involved, and the more all levels know and understand about the procedures, the better everyone will feel about their contribution to the total project. Upgrading and training, schooling, workshops, and inservices are all types of growth situations necessary to provide employees with the information needed to do the best job possible. In the field the welders must know how to read a blue print, must understand welding symbols, and must be able to relate that information to their welds. They must understand why procedures are required and why they must be enforced. The more information everyone has about the total project, the better work everyone will demonstrate. Thank you. (Applause)

Mr. Steele: Thank you, Mort. Our next feature is a widely misunderstood subject that needs to be addressed at every construction site. This is about hearing protection and what can you do to prevent hearing loss at your work place. It will be presented by Michael Selway, a Certified Industrial Hygienist, in the position of Director of Industrial Hygiene with the Chicago and Northwestern Transportation Company.

Mike has been with the C&NW for nearly 5 years and received his BS degree from Michigan State University. He Holds a Master of Science Degree from the University of Illinois School of Public Health. Mike has also spent 6 years with OSHA so is well versed on their requirements. Mike.

ON SCHEDULE FOR A HEALTHY SOUND ENVIRONMENT

Mike Selway

Director Hygiene
Chicago and North Western Transportation Company

To railroaders, the importance of maintaining a safe and healthy work environment has become recognized as being important to us as individuals, as well as to our industry as a whole. One important aspect of a safe and healthy workplace is that it not interfere with our ability to hear. In this paper I will present some basic explanations of what noise is, how it affects us, and some things being done to control it.

What is Noise?

Noise is usually defined as an unwanted signal. In the case of hearing conservation noise can be defined as unwanted sound. Noise might or might not damage hearing. Whether or not it damages hearing is dependent on two variables; first, how loud the noise is, and second, how long an individual is exposed to the noise at a given volume. If noise is unwanted sound, what is sound?

Sound is slight, rapid variations in atmospheric pressure. Sound is created by the vibration of a physical object. The object might be a piece of steel, an insect wing, a high speed exhaust plume, a guitar string, or a set of vocal chords. When an object vibrates, the surface moves back and forth. When the movement is in one direction, the air next to it is physically displaced, causing a slight increase in atmospheric pressure. A slight decrease in the air pressure immediately adjacent to it occurs when the surface moves back in the opposite direction. These increases and decreases in the atmospheric pressure are described by the terms compaction and rarefaction. These compactions and rarefactions, which travel at approximately 1100 feet per second in air, are also referred to as sound waves. The sound waves propagate in all directions, until they come in contact with a material which causes their deflection or absorption. If they are absorbed they are converted into heat. As the sound waves propagate, their energy is spread over a wider area, making their intensity less at any given point on the front of the propagating wave. Sound waves can be described as sine waves. The strength, or amplitude, of these waves will determine what is commonly referred to as the volume of the sound.

The distance between two analogous points on two successive parts of a sound wave is the wavelength. The rate at which sound waves pass a given point determines their frequency. Since all sound waves are traveling at the same speed at a given point, the frequency of their repetition is dependent on their wavelength. The unit used to describe frequency is hertz, abbreviated Hz. Hertz stands for cycles per second. A cycle is one complete sound wave. The speed, frequency and wavelength of sound are related by the following formula:

$$C = \lambda f$$

where C = speed of sound in feet, seconds or meters per second
λ = wavelength in feet or meters
f = frequency

Most industrial noise is distributed over a wide range of frequencies, but varies in terms of the intensity at each frequency. Exceptions to this might be whistles or horns.

Different frequency scales are used to characterize sound. The C scale is basically flat with regard to the energy at each frequency. When the sound level is plotted against frequency, using the C scale, one gets close to a flat line. (The line actually drops off slightly at the very low and very high frequencies.) Another scale, called the A scale, gives much less weight to the low frequencies, especially under 500 Hz. The A scale is what is used for most noise standards in the United States. There are a couple of reasons for this. One is that the human ear does not respond as well to the lower frequencies. Also, the lower frequencies are not considered by most audiologists to be as harmful to hearing as higher frequencies.

Another aspect of sound is its quality or timbre. This results from harmonics and is beyond the scope of this presentation. This is what gives musical sounds their character. The quality or timbre of a sound is not a major concern in evaluating its impact on hearing loss, although it can affect its psychological impact and might be related to non-auditory health effects.

The Decibel

The term most commonly used to describe the intensity of sound is the decibel.

The mean, or average, pressure change in a sound wave, relative to the normal atmospheric pressure, is equal to zero because half of the pressure wave, the compaction, is positive relative to the average atmospheric pressure. The other half, the rarefaction, is negative. Consequently, a measurement is needed which adds the effects of compactions to the effects of rarefactions. This is accomplished by squaring the value of the pressure disturbance at each instant, averaging the squared values over a sample time, and then taking the square root of this average. The term used to describe this calculation is root-mean-square, or rms.

The decibel is not a unit, but it is a relative value. It is also not a term that is unique to sound, although for purposes of this presentation when I refer to decibels I will be talking about the decibel sound scale. The decibel is a comparison of the rms sound pressure level to a reference value. In the case of the decibel noise scale, that reference value is a sound pressure level of 20 micropascals. A Pascal is equal to one newton per square meter, and is approximately one one-hundred-thousandth of normal atmospheric pressure.

A sound pressure of 20 micropascals is zero on the decibel scale, and is considered the quietest sound that a person with ideal hearing can detect in a quiet environment.

While a sound pressure of 20 micropascals is the quietest sound that can be heard, an extremely loud sound, say 120 decibels, represents a sound pressure of about 20 pascals. Twenty pascals is a million times greater than 20 micropascals. Because of the wide range of sound pressure levels that are of interest in noise measurement, a scale is used which condenses this range (and causes considerable confusion to those who do not understand it). The decibel scale is not a linear scale, but rather is a base-10 logarithmic scale. There are some important things to understand when looking at a decibel reading, without going into a lot of detail about logarithms.

The first is that when the sound pressure from a source is doubled, the theoretical increase in the decibel reading is approximately three decibels. In other words, if we took a sound reading while standing 20 feet from a source which read 90 decibels, and then added a second source next to the original source, which by itself also produced a reading of 90 decibels, the resulting decibel reading we would expect with both sources operating would be approximately 93 decibels.

Every time the sound pressure level doubles the sound level increases approximately three decibels. A 10 decibel increase in the sound level represents approximately a ten-fold increase in the sound pressure.

Noise-Induced Hearing Loss

In order to understand noise-induced hearing loss, it is first important to know something about the structure of the ear and how it works.

The human ear is divided into three different sections commonly known as the external, middle and inner ear. The external ear consists of the pinna, or outer part of the ear, the external auditory canal, and the tympanic membrane, or ear drum.

The middle ear is located in a region between the ear drum and the inner ear. It consists of a cavity, filled with air, in which are found three small bones called the malleus, incus, and stapes. Because of their shapes these bones are also called the hammer, anvil and stirrup.

The inner ear consists of a structure called the cochlea, and the semicircular canals. The semicircular canals are related to our sense of balance. The cochlea, which looks like a snail shell, contains structures which are immersed in fluid. The structures are called the basilar membrane and the organ of corti. The organ of corti lies along the basilar membrane, and contains millions of hair cells. The location of the hair cells along this membrane is related to the perception of pitch.

As sound waves strike the outer ear they are channeled into the ear canal by the pinna. As the sound waves strike the ear drum they cause it to move or vibrate. The movement of the ear drum is transmitted and amplified by the bones of the middle ear to a membrane at the end of the cochlea. As the bones of the middle ear move, they set up waves in the fluid inside the cochlea. As the waves move through the cochlea they cause the hair cells along the organ of corti to move. The movement of these hair cells is converted into neural signals which travel to the brain, where they result in the sensation of hearing.

When the hair cells of the cochlea are repeatedly impacted by loud noise of sufficient intensity, they will fatigue. If you have ever been exposed to loud noise, without any type of hearing protection, you may have noticed after the exposure ceased that it was more difficult to hear. An example often used to illustrate this is an individual who listens to the car radio on the way to work. When that person returns to the car after working in a loud noise environment, he or she finds it necessary to turn up the radio from where it had been in the morning, in order to hear it clearly. After being home and away from work overnight, returning to the car, and turning on the car radio, the individual is amazed at how loud the volume is set. I have heard this scenario described by many individuals who work in loud environments. This is an example of a phenomenon called a temporary threshold shift, and it relates to the very insidious nature of noise induced hearing loss. The temporary loss, which can simply be explained by the fatigue of the nerve cells, disappears as the cells have time to recover. After a night's rest, away from any other loud source of noise, the recovery might be 99% complete. To the subjective sense of the individual it appears that his hearing has returned to normal (and he turns down the blasted radio!). However, in reality, there might still be a slightly less than full recovery. If that individual returns to a noisy environment, that slight loss might never be recovered. The individual will probably not notice the loss initially, but if this scenario is repeated over and over, the slight losses which occur will accumulate. As the effects of these losses accumulate, they eventually become significant, and they are no longer temporary. Once such a hearing loss occurs, it is permanent. Medicine has not yet devised a way to repair hearing loss caused by chronic noise exposure.

Other physiological effects have been related to loud noise exposures. Among these are increases in blood pressure and damage to the circulatory system, specifically to peripheral capillaries. Loud noise can also increase the psychological stress of trying to function in such an environment.

Workplace Noise Regulation

Because loud sounds can be injurious, OSHA has regulated noise exposures since the early 1970s. Until the early 1980s, the OSHA regulation consisted of the Permissible

Exposure Limit, or PEL, for noise. This set the maximum allowable exposure, when averaged over eight hours, at 90 decibels. The maximum allowable exposure varies with duration. The OSHA PEL incorporates a five decibles doubling rate. This means that for every increase in the sound level of five decibels, the allowable exposure time is halved. Under the OSHA PEL sound levels under 90 decibels are not regulated. It is estimated that in a healthy workforce, exposed to levels of 90 decibels for a 40 hour work week over several years, a significant hearing loss will occur in a significant percent of the population. In other words, the 90 decibels PEL is really not protective for the entire workforce.

In the early 1980s the hearing conservation amendment to the OSHA noise standard was enacted. The hearing conservation amendment made it mandatory for companies which fell under the OSHA regulations to enact a complete hearing conservation program in areas where noise exposures exceeded 85 decibels when averaged over eight hours. Again, a five decibels doubling factor is in effect in determining when a hearing conservation program is required.

The Federal Railroad Administration sets limits on noise levels in the cabs of locomotives, and also has established limits on noise levels at the boundaries of railroad property. The FRA does not have limits in place which will protect railroaders' hearing. If such protection is to be assured then OSHA standards should be followed. The jurisdiction of OSHA and FRA in regard to railroads seems to be an ongoing issue which might never be completely resolved. Among most people who are involved with this issue with whom I have spoken, it is currently assumed that OSHA has jurisdiction in shops, FRA has jurisdiction on mainline tracks, and the jurisdiction in other areas depends upon the specific situation.

Hearing Conservation Programs

Five important parts of a hearing conservation program are noise exposure monitoring, training, audiometric testing, personal hearing protection, and engineering and administrative controls.

Noise Measurement

Industrial noise measurement generally takes two forms, spot measurement with a sound level meter, and exposure measurement using a noise dosimeter. Spot noise measurements indicate the noise at a specific location and at a specific time. For example, if one wants to know how loud a ballast regulator is at the operator's position, one can get that reading while the machine is operating through the direct readout of the sound level meter held at that position. It is important when taking a sound level measurement on a noise source that the location of the sound level meter relative to the source is specified, along with conditions under which the source is operating. To say that an air jack operates at 95 dBA does not really give much useful information. Was that 95 dBA measured six inches from the exhaust port, or was the measurement taken at a point six feet away from the exhaust port?

Noise Exposure Limits

TABLE I
OSHA PEL

Time	Sound Level
8 hours	90 dBA
4 hours	95 dBA
2 hours	100 dBA
1 hour	105 dBA
1/2 hour	110 dBA
1/4 hour	115 dBA

TABLE II
HEARING CONSERVATION

Time	Sound Level
8 hours	85 dBA
4 hours	90 dBA
2 hours	95 dBA
1 hour	100 dBA
1/2 hour	105 dBA
1/4 hour	110 dBA

Table I represents the allowable time-weighted- average exposure under the OSHA Permissible Exposure Limit. Table II indicates the time-weighted-average exposures at which a hearing conservation program must be implemented.

Sound level readings are useful as a screening tool to get an idea whether an overexposure to noise is possible. If the sound environment is constant, and an individual being monitored does not move around much in the environment, and the duration of an individual's presence in the environment is very predictable, a sound level meter might give a fairly good indication of what an individual's over-all exposure will be on any given day. In most cases in industry, and certainly in most cases on railroads, there is a lot of variability in the sound environment. As noted above, in determining actual noise exposures both the intensity of the noise and the duration of the exposure have to be considered in determining an overall exposure. If through screening with a sound level meter, or by other means, it has been determined that exposures might be significant, noise dosimetry will determine actual exposures. A noise dosimeter is a device which averages sound levels over a period of time, to get a time-weighted-average (TWA) exposure level. An individual whose exposure is being measured wears the noise dosimeter, with the microphone clipped to his or her collar or shoulder. The microphone continuously picks up noise in the environment in which it is worn. The intensity of the noise directly affects the electrical output of the microphone, in terms of both its frequency distribution and its amplitude. The dosimeter processes this signal and records a history of the exposure period monitored. In this way an individual's actual exposure over a work shift, or other period of time, can be determined. Judgments still have to be made considering whether or not the time period monitored is representative of the individual's typical exposure.

Audiometric Testing and Training

The best way to tell how well a hearing conservation program is working is to monitor hearing ability through audiometric testing. Because individuals, even individuals who have no hearing loss, vary in their ability to hear, it is first necessary to obtain a baseline against which future hearing tests can be compared.

When an individual is given a hearing test, an audiogram is generated. The audiogram indicates the individual's ability to hear a pure tone at a minimum of six different frequencies: 500, 1,000, 2,000, 3,000, 4,000, and 6,000 cycles per second, or hertz (Hz). When an individual is given the audiometric test he or she is seated in an audiometric test booth or other quiet environment and fitted with a pair of headphones. The individual is then presented with a pure tone signal at each of the frequencies noted above, one ear at a time, and asked to respond when he/she can hear the signal. The response might be a hand indication, or the press of a button, depending on the type of testing equipment being used to administer the test. The responses are recorded on a form called an audiogram. Audiometric zero on the audiogram is considered to be the minimum sound that can be heard by a healthy young individual, and is set at a sound pressure of 20 x 10-6 newtons per square meter. The louder the signal administered must be to elicit a response by the individual being tested, the farther from audiometric zero this response will be indicated on the audiogram.

Noise-induced hearing loss is often evidenced on an audiogram by a "notch" at around 4,000 Hz. This is the range at which such a loss is first evidenced. One theory for this pattern of early loss is that it relates to the structure of the inner ear. It is not generally correlated with the frequency distribution of the sound to which the individual experiencing such a "notch" was exposed. As the noise induced hearing loss becomes worse, it will spread to the lower frequencies. The frequencies of 500, 1,000 and 2,000 Hz are important to the understanding of human speech. A loss of hearing acuity at these frequencies can affect an individual's ability to understand speech. The ability to understand speech is given emphasis in the OSHA regulations and in the way compensatory awards are determined.

Once an individual has been given a baseline audiogram, he/she is retested annually. Each subsequent test is compared to the baseline. Slight variations in background, equipment, and subjective factors in responding to the signal during an audiometric test session can result in some variation in test-to-test results. It is very likely that two audiograms taken on two subsequent days by the same individual will have slightly different results; however, the results should be close. When a test taken subsequent to the baseline shows a change for the worse of an average of 10 decibels or more, averaged over 2,000, 3,000 and 4,000 Hz, the change is considered by OSHA to be a "Standard Threshold Shift" or STS. Once an STS occurs for an individual, certain actions are required. Within 30 days the individual must be informed of the results of the test and the fact that an STS has occurred. The use of hearing protection should be reviewed with the individual. Under OSHA, the use of hearing protection is mandatory for all individuals whose eight-hour exposure exceeds 90 decibels. If an individual has an STS, the cutoff for mandatory hearing protection for that individual drops to 85 decibels.

Also, audiograms and medical histories are reviewed to determine if there is anything unusual which could warrant medical attention. If such is the case, the employee is so informed and medical follow-up is recommended.

Training is often combined with audiometric testing. Under the OSHA regulations, employers are required to offer audiometric testing to employees who are exposed to noise levels which exceed 85 decibels eight-hour TWA. Training regarding the effects of noise on hearing, the use of hearing protection, and the procedures and interpretation of the results of audiometric testing is mandatory for employees exposed above 85 decibels eight-hour TWA.

While audiometric testing and training are very important aspects of hearing conservation, they do not do anything by themselves to reduce the incidence of hearing loss. The only way to prevent hearing loss is to reduce noise exposures at the ears to levels below those which can damage hearing.

Engineering and Administrative Controls

Although individuals can usually be protected from noise-induced hearing loss by wearing effective hearing protection devices such as ear plugs or muffs, a more reliable way to insure that hearing loss will not occur is to engineer out the noise. An example of engineering controls is the creation of barriers to enclose a source, or to block the noise path between the source and individuals around it. Also, damping of surfaces with a combination of noise absorbing and vibration-reducing materials can help reduce the transmission of sound waves. Noise-absorbing materials can be used to cut down on noise reflection. This type of control is especially effective in highly reverberant environments. Additionally, machine maintenance can often significantly reduce noise levels, as can the use of proper mufflers on engines. The subject of noise control is extensive, and a complete discussion is not possible here, except to say that it is important to always look at the possibility of engineering out noise. Such a solution, where feasible, is the best way to protect hearing.

A type of noise control that has received a lot of attention recently is the use of active noise cancellation. As noted earlier in this discussion, sound is composed of slight variations in air pressure, which can be characterized as waves. If sound waves which are exactly out of phase with the sound waves being emitted from a noise source can be generated, then, theoretically, the sound waves from the source will be canceled out. The technology for this type of control is very appealing and is feasible in some environments today. Its use seems to be most applicable to noise environments where the sound is relatively constant and predictable, such as fan noise in a ventilation system. Considerable work is ongoing to improve the technology for this type of noise control, so it might be applicable to a wider variety of situations in the future.

Another way to reduce exposure is to implement administrative controls. This usually means limiting the amount of time an individual can be in an environment which has high noise levels, so that the time-weighted-average exposure does not exceed 85 decibels.

Even with administrative controls, I recommend that hearing protection be worn whenever exposures exceed 85 decibels. When engineering controls are being implemented in an area of high exposure, or where effective engineering controls are not feasible, then hearing protection must be worn.

Personal Hearing Protection Devices

Hearing protection devices fall into two broad categories of plugs and muffs. In these broad categories there are a variety of devices. How does one decide which type of hearing protection is most appropriate for a given situation? Once a type of hearing protection is selected, how can one be sure that it is adequate?

First of all, with hearing protection, as with all personal protective equipment, the specific make and model of device that is most effective is that which is worn. This means that the device has to be comfortable and must not interfere with job performance. A device that is comfortable for one individual might not be comfortable to another. In addition, the device should be one that can be properly maintained and used in the field.

How can the effectiveness of hearing protectors be evaluated? All hearing protection comes with a Noise Reduction Rating (NRR). The NRR is usually found on the packaging or enclosed with the device. If a hearing protection device does not have an NRR, then it should not be used. The NRR represents the attenuation that the device gives under a specific set of laboratory conditions. The attenuation a device gives varies with frequency, but the NRR is a good indication of over-all attenuation. Under the OSHA Noise Standards, methods for evaluating hearing protection are given. OSHA does not allow the full NRR to be assumed to be an accurate representation of a device's actual field attenuation, because the NRR is obtained under ideal laboratory conditions, while in the field the protection might not be worn most effectively. Also, variations in the physical characteristics of the individual wearing the device can affect its attenuation.

Under the OSHA Noise Standard a hearing protection device being worn in an environment which has been characterized using the A-weighted decibel scale is evaluated according to the following formula:

$$\frac{\text{NRR} - 7}{2}$$

Take the NRR, subtract 7 from it, and divide the difference by 2. This formula compensates for the A-scale weighting, and then apply a 50 percent safety factor to the NRR.

There are some other devices available on the market which combine technologies to make the use of hearing protection more plausible in specific situations. Examples of this are noise-silencing radio headsets, headsets which incorporate noise-canceling devices such as were described above under engineering controls, bone conduction headsets which allow improved communication while wearing ear plugs or muffs, and muffs with various types of tuned ports or filters which allow passage of specific types of sound while significantly lowering the overall exposure.

One final area of consideration in the use of personal hearing protection is how its use might or might not interfere with one's ability to communicate, or to hear desired auditory signals. Such signals might relate to effective job performance and safety. The subject of signal detection while wearing hearing protection is an area of ongoing research. It can be said that hearing protection does not lower one's ability to hear desired signals any more than unwanted background noise interferes with such signals. In discriminating a desired signal from background noise, the differences in the desired signal and the background are what make the desired signal detectable. Hearing protection lowers the perceived volume of the desired signal, but it also lowers the volume of the background noise, so that those differences still exist. There can be some difference in the frequency make-up of the perceived sound due to uneven frequency attenuation of the hearing protection. If one does not wear hearing protection in a loud environment, auditory fatigue will decrease the ability to discriminate desired signals as the work day progresses, and this will likely have more of an effect on auditory thresholds than the hearing protection would have.

Another phenomenon which can occur in very loud environments is called "cochlear distortion." This happens when the ear is unable to distinguish between speech, or some other desired signal, and background noise, because the sensory apparatus is overwhelmed. In such a situation, hearing protection will improve the ability to understand speech because it lowers the overall sound to a level that does not cause the sensory apparatus to be overwhelmed. If engineering or administrative controls are not feasible or adequate in a loud environment, the alternative to wearing hearing protection is likely to be a hearing loss. Consequently, every effort should be made to learn to do the job with hearing protection. It is important to realize that the use of hearing protection often requires some relearning and adjustment on the part of the person wearing the protection. Look for the device that is most comfortable, and attenuates unwanted noise most efficiently while allowing desired signals through. Such an evaluation is very subjective, and the device that works for one person might not be best for another.

Why Have a Hearing Conservation Program?

What are some motivations for a company to establish a hearing conservation program? Although there are probably many more answers to this question than I am aware of, the words that come to mind which sum up some of these reasons include quality of life, the law, and litigation.

First, consider quality of life. (Perhaps, in a cynical way, most would not consider this to be the first priority.) When I became involved in the field of industrial hygiene, I realized that I would eventually want to earn the professional designation of Certified Industrial Hygienist, or CIH. Having gained this credential, I received a document entitled, "The American Academy of Industrial Hygiene Code of Ethics for the Professional Practice of Industrial Hygiene". In this document is the statement that "...the primary responsibility of the Industrial Hygienist is to protect the health of employees." Healthy hearing is an important part of overall well being. While one can learn to cope with a loss of hearing, such a loss can have a significant impact on one's quality of life.

Related to this is morale. Employees who work in noisy environments usually know it, and they know that the noise adds to the stress of the job, and that it has an impact on their health, and most obviously on their ability to hear. There might have been a time in the past when noise, and its negative impact, was accepted as part of the job. Now, both employees and employers are aware of the hazards of excessive noise. If employees work in a situation where such a physical hazard exists, and no effort is made to help protect them from that hazard, it can only have a negative impact on their job performance.

Next is the law. The law mandates that employees be protected from hazards in the workplace, and ignoring the law in this area can result in civil and even criminal sanctions.

There is another more positive way in which I like to consider hearing conservation. There has been a hidden cost to all of our citizens resulting from the impact of environmental hazards. This hidden cost is manifested in low morale, loss of quality of life, loss of productivity, and increased health costs. These costs have a negative impact on business as well as society in general. Companies that face these hidden costs, and deal with them, will in the long run have a brighter economic outlook.

All companies need to conserve resources to operate most effectively. The most important resource a company has is its workforce. I have already touched on subtle reasons that hearing conservation conserves our human resources. Less subtle are new laws, such as the Locomotive Engineer Certification Standards, under which employees can be disqualified from service if they do not have a minimum ability to hear.

Finally, there is litigation. Under FELA, railroads face the liability of hearing loss among railroad employees. Nowhere is the saying, "an ounce of prevention is worth a pound of cure," more true. The cost of maintaining a hearing conservation program is very small relative to the cost of compensation, under any system, whether it be Workmen's 10 Compensation or FELA. Claim settlements for hearing loss vary a great deal, but, even ignoring the less obvious costs to which I referred earlier in this paper, and considering claim costs alone, the several hundred dollars that it might cost to keep an employee in a hearing conservation program for a period of years amount to nothing compared to the cost of a hearing loss claim.

Summary

Excessive noise exposure can produce hearing loss. Engineering and administrative controls, along with the effective use of personal hearing protection and audiometric testing, can form a hearing conservation program which will protect the hearing of all railroaders. Such a program requires a high level of commitment on the part of officers and contract railroaders to be successful.

President Walbrun: Thank you, Mike. Our next presentation is a committee report, and Special Subject Chairman John VanHuis will introduce the chairman.

Mr. VanHuis: Our next presenter is Doug Williams, engineer of structures with Conrail. Previous to this position he held positions of senior structural inspector and assistant B&B supervisor. Doug holds an ABS degree in civil engineering from Penn State and an B.S. in mathematics from Bloomsburg University of Pennsylvania. Doug.

Special Subject No. 1

Bridge Inspection: Who, When, and How

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Webster's definition of "inspect" is "to view closely and critically".

Using a questionnaire, the committee solicited information from various railroads concerning their bridge inspection programs. The responses indicate that no two carriers defined their inspection requirements alike. While the tools may have been similar, the "Who, When, and How" were very diverse.

The allocation of resources for a comprehensive inspection program should reflect the "Who, When, and How". The following should also be considered when allocating resources:

- Safety above all other considerations. This stands as the number one reason that governmental agencies involve themselves in bridge inspection and maintenance.
- Assessing priorities. This enables the number of emergencies that pop up to be minimized, and enables an increase in production through planning. Flexibility of maintenance programs is also increased, and the number of temporary fixes reduced.

The prevention of more costly repairs and failures should also be considered along with the inferred revenue savings that may have been lost due to delays and liabilities.

Who

The survey revealed that inspections are performed by several different B&B crafts, supervisors, and/or engineers. Their training included OJT, in-house workshops, seminars, and/or formal educations. The programs were typically overseen by a manager with an engineering degree. The significance of the inspecting personnel's credibility increases with the growing concern over railroad bridge conditions by governmental agencies.

Section 7.4.2 of the AREA Manual for Railway Engineering recommends that each district or division should have one or more competent inspector(s) within each maintenance unit. It does not get specific in regards to qualifications.

The National Bridge Inspection Standards, enacted as part of the Federal Aid Highway Act of 1968, provides for minimum qualifications of NHWA Certified Inspectors and for two levels of supervision. Their standards require that:

- The unit leader be a professional engineer or have 10 years of experience in a responsible capacity and comprehensive training.
- The team leader be a professional engineer or have five years experience in bridge inspection and comprehensive training.
- The inspector must have advanced bridge inspection training and preferably possess a degree. He should also have organizing and reporting skills, have the proper attitude and motivation, and possess the physical ability required.

This committee's intent is not to recommend qualifications. The committee does suggest, however, that the carriers review their standards. Where none exist, the committee suggests that standards be established.

Establishing standards for qualifications and training are essential in developing a quality program with credibility. In addition to having a work history indicating self-motivation and integrity, an inspector should:

- Be able to prepare detailed sketches and reports
- Understand terminology and nomenclature
- Be adept at climbing and crawling

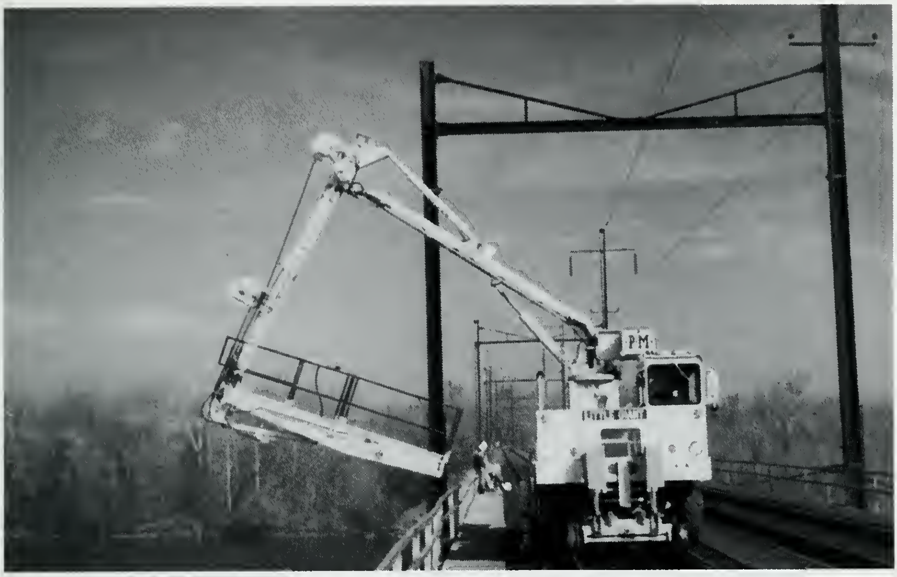
In addition to in-house training and field instruction, the American Railway Bridge and Building Association and various universities hold seminars that are highly recommended. Inspectors should understand concepts such as fatigue, fracture critical, and the different stress types.

Many carriers also contract the services of outsiders for specialty items, such as:

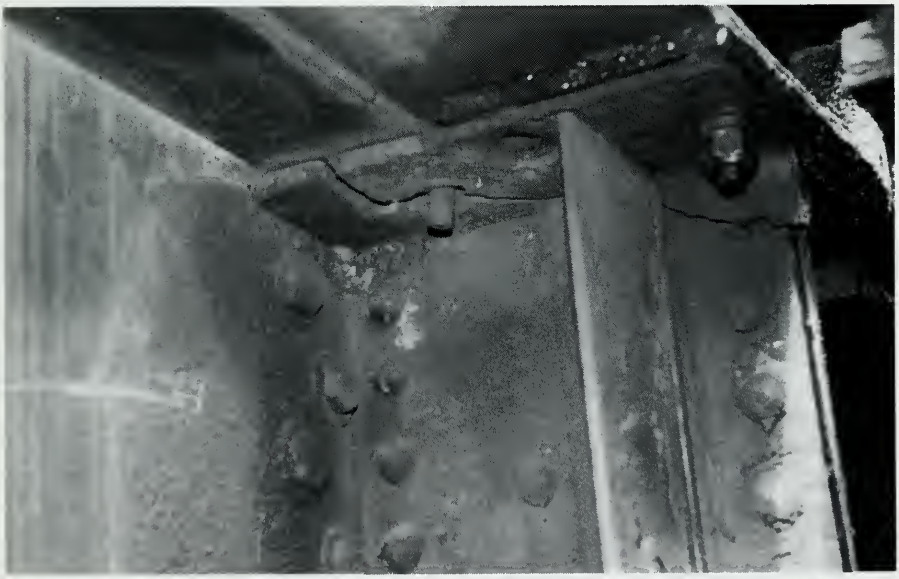
- Professional climbers
- Underwater inspection
- Acoustical crack detection
- Current induction analysis
- Inspection of confined spaces
- Strain gage analysis

Most of the contractors provide an on-site professional engineer during the inspection.

More than one carrier contracts all of their bridge inspections.



Use of a Hi-Rail Snooper permits inspection of inaccessible areas.



Open deck bridges, movables, and high speed lines are exposed to greater impacts.

When

The committee found that most carriers responding inspected all structures over five feet at least once a year. The assumption was made, however, that those with no inspection program would not reply. The results are further distorted by the assumption that the carriers with better programs would be most apt to respond. There was contradiction to that logic. One of the respondents reported that their structures were typically inspected at 12-year intervals.

Part 21.1.1 of the AREA Manual recommends all structures be given a thorough, detailed inspection at scheduled intervals. The maximum interval should not exceed one year. Part 7.4 recommends annual inspections and regular scheduled intervals. Once again, it is not this committee's intention to recommend specific standards, but rather to suggest that responsible standards be established where needed.

The following should be considered when establishing inspection frequencies:

- Age of the structure.
- Type of traffic, volume, and speed. Note that speed is a square function of impact.
- Deck type. A ballast deck bridge provides a better distribution of loads. The impact is greatly reduced, along with fatigue. A certain amount of redundancy is also offered should problems develop in the floor system.
- Construction materials. This goes hand-in-hand with the age of the structure. The use of substandard concrete with or without rebar, the use of cast or wrought iron, or the use of timber increases the probability of more rapid failures.
- The bridge type. Fracture critical members are abundant in a pin connected truss, whereas a concrete box typically is a stable, slow failing structure.
- Clearances. The propensity of a structure to be struck by trucks or vessels and the possible consequences should be examined.

The most conservative frequencies reported were:

- All structures are thoroughly inspected yearly
- All open deck bridges are inspected twice a year
- All movables in service are structurally inspected every month
- All timber bridges are inspected twice a year

Note that the intervals listed were minimum frequencies. Additional inspections are scheduled when conditions warrant.

What time of year a bridge is scheduled should also be examined. Open deck bridges in the snow belts shouldn't be scheduled during the winter months, due to safety considerations and the ability of an inspector to perform a detailed inspection. It may be easier to inspect culverts, boxes, and arches during the winter where foliage is a problem. Other culverts, boxes, and arches may have to be inspected during dry seasons. Schedules may have to be flexible until patterns are established.

How

The number one cause of bridge failure in the country is due to scour and undermining of the substructure. Only about a third of the responses to the questionnaire indicated that soundings were taken when inspecting bridges. Another third said soundings were only taken at problem bridges. Note that without a permanent record of the channel, it would be difficult to determine when a bridge becomes a problem. The remaining third indicated that they did not take soundings at all.

There are several ways to insure complete, thorough inspections.

Methods for monitoring a channel are:

- Soundings – After a sketch is made part of a permanent record, subsequent sounding changes may be recorded on copies.
- Probing – While hard to accurately record, this is necessary for locating voids and undermining.
- Sonar – This option is the most accurate record available. Some units also have a limited capacity of displaying silt depths.
- Underwater inspection – This is the only method of performing a hands-on inspection in deeper channels.

Most of the carriers said inspections were carried out by both individuals and teams, depending on the structures. Some situations requiring the use of a team may be:

- When the use of a snooper is required. This equipment allows for a hands-on inspection of most inaccessible areas under a bridge.
- When the use of a bucket truck or hi-lift is needed. These also allow a hands-on inspection of inaccessible areas.
- When climbing is involved.
- When inspecting large structures.
- When inspecting confined spaces.

While team inspections require additional manpower, the total time spent is generally not significantly more than the time consumed by an individual. Other items which may make inspections safer or more efficient are:

- The safety harness – A full body harness should be used. Safety belts should not be recognized or utilized as fall protection.
- A climber's helmet – Hard hats are cumbersome and not desirable for climbing, but protection should be provided.
- Knee and elbow pads
- An increment borer
- A folding ladder – This OSHA approved version is easily transported, light, and replaces all but the extendable ladder.
- A hi-rail pick-up – If traffic permits, the use of a hi-rail can substantially reduce travel time.
- A dye penetrant kit
- A sounding tape
- A probing rod
- A camera
- An inflatable raft

An inspector should also have a hammer, a punch, a wire brush, waders, tapes, a shovel and a waterproof flashlight.

Defining how a bridge is to be inspected, and at what intervals, will dictate what resources should be allocated. Examining what is defined as being required in a partial inspection, and scrutinizing what is involved in a thorough inspection, will provide an idea of the time needed.

The transit time between bridges, at the beginning of the day, and at the end of the day, generates most of an inspector's downtime. Each line should be evaluated and the following considered:

- The average travel time from and to the inspector's headquarters.
- The economics behind having the inspectors in a hotel.
- Whether train traffic permits the use of a hi-rail.
- Accessibility of the bridges by right-of-ways or highway.
- The amount of walking time.

Should a program include partial inspections (that being anything less than a thorough inspection), what they encompass should be outlined and analyzed in the same manner as a detailed inspection.

Delving into the AREA Manual, there are three sections providing instructions on what should be examined in the course of a thorough, detailed inspection.

Part 3.3 describes the manner of inspecting a timber structure. Those instructions specify that regardless of the location each timber should:

- Have surfaces inspected for various failures listed.
- Be sounded, especially at contact points and at ground or water lines.
- If treated and hollow, be increment bored. The extent of damage should be determined, water drained, and the holes then plugged.
- Be checked for destructive insects.

Those instructions also specify:

- That the details are to be recorded and that the bridge, members, and inspection party are properly identified.
- That the channel be scrutinized for changes.
- That the track conditions and any problems be recorded.
- That the tie, guard timbers, walks, railings, refuge bays, and stringers are examined and conditions noted.
- What to examine and make note of with respect to piles, posts, caps, girts, sills, bents, towers, sway and sash bracing, and struts.
- That the bridge be observed under traffic if practical.
- That fire protection be checked out and noted.

Part 7.4 concerns the inspection of steel bridges. This section proposes:

- That an accurate record of the physical condition of every bridge be kept, and that any changes be noted.
- That the reports submitted by the inspectors state the conditions of all components.
- That the inspector report any indication of overload or failure in any part of the bridge.
- That the bridge be observed under live load, if practical.

It also suggests that the following items be covered in detail:

- The track surface, alignment, and probable causes of problems.
- Ties, guard timbers or rails, walks, and handrail.
- Bearing areas.
- Expansion.
- Straightness and alignment of members, including slack eyebars and counter adjustment.
- Cracks in stringer connecting angles, stringer and girder flange angles under bearings, hangers, pin plates, angle fillets of flanges and posts, end sections of lower chords and flanges over or near bearings, end of cover plates, coped floor beam webs, lateral bracing and cross frames, welds on bracing/frames/stiffeners, and other welded details.
- Rivets, bolts, pin holes, and nuts. Pins should be observed under traffic.
- Corrosion.

Part 21 deals with the inspection of concrete and masonry structures. It suggests:

- That all concrete and masonry structures should be given a thorough, detailed inspection at scheduled intervals, not exceeding one (1) year.
- When subjected to acts of nature, vulnerable structures may require a special inspection.
- That preprinted forms be used to report conditions.
- Photographs be taken and filed so as to determine changes.
- If possible, structures should be watched under load.
- Cracks be noted, size and lengths recorded, and points established for future reference.

The AREA directions also propose that the following be covered in detail:

- Track surface, alignment, and causes of problems.
- Streambed or waterway for scour (by sounding), alignment, debris, and slope protection.

It further specifies:

- That cracks in foundations, piers, and abutments should have reference points established and measurements taken. The crack widths and lengths should be marked to determine progression and stability.
- That retaining walls be checked for movement.
- That plugs be placed at intervals in tunnels to permit measurement of any shifting or bulging.
- That arches be checked for settlement, spalling, scour, undermining, loss of joint mortar, drainage, alignment, sagging, bulging, and cracks.
- That headwall undermining, cracks, settlement, separations, or change in drainage area be noted when inspecting culverts.

Part 21 also goes into great detail on reporting results and on a suggested inspection form format.

Along with inspection reporting and keeping permanent records, reporting the change in conditions is recommended several times. The nature of change, rate of propagation, and rate of decay are essential data in assessing priorities. Along with pictures, reference marks with accurate measurements should be made part of a permanent record. The recommendations also propose lists of items to inspect which encompass nearly all bridge components.

How Many

Our questionnaire revealed that the approximate number of bridges inspected per inspector each year ranged between 200 and 2,100. The average of those responding was about 900. Those inspecting 200 bridges a year were maintenance supervisors with other primary duties. Unless there are only 200 structures on their territories, their programs are not all inclusive. The most conservative program averaged 400 inspections a year by personnel whose sole responsibility was that of an inspector. About 40 percent of the carriers ranged between 600 and 1,000. One of the programs utilizes an inspector and assistant inspector as a team and completes 400 thorough plus 1,000 partial inspections a year.

Unless an inspector has nothing but concrete boxes in new condition, it's not feasible that he complete much more than 1,000 thorough, detailed inspections, as prescribed by the AREA, in a year. One thousand five hundred (1,500) or 2,000 inspections do not allow adequate time for climbing, setting and checking reference marks, sounding, probing, or eating lunch. The inspector with primary duties other than bridge inspection cannot complete 600 to 1,000 thorough inspections either. One third of the carriers responding indicated that their inspectors had other primary duties.

As a final note, deferred maintenance should not result in a lax inspection policy. Inspection becomes more critical in avoiding problems which may lead to failure. Developing and maintaining credibility may be the only means of avoiding outside intervention.

Thank you. (Applause)

Mr. Steele: Thank you, Doug. That was very interesting. Next we'll have Joe Lileikis give us an update on our bridge inspections seminars.

Mr. Lileikis: The American Railway Bridge and Building Association conducted two bridge inspection seminars this year. We had one in April in Denver, Colorado, and one in May in Pittsburgh, Pennsylvania. The seminars were attended by about sixty people overall. A lot of positive comments were given to us in feedback on these seminars and we received a lot of requests to continue with these seminars. We came up with what we thought was a very reasonable cost and it turns out we are about half the price of the bridge inspection seminars put on by universities. The big difference between ours and theirs is ours is geared totally towards railroad structures. We do not work with any highway loadings or highway structures at all. It is strictly railroads. That kind of differentiates us and separates us from the other seminars.

Our's were three-day seminars, and they were very well attended by division engineers, chief engineers, bridge inspectors, consultants and in one case we even had an FRA bridge inspector attend. The FRA, as a lot of you people are well aware, is becoming involved in the inspection of railway structures.

Bill Nelson is going be in charge of next year's seminars and will give you more information on them.

Mr. Nelson: Thank you, Joe. Bridge inspection is getting to be more and more of an important thing for all of us. And if we don't have our house in order some day, and the federal government starts to look at our structures in a manner in which they are looking at our track structure, we may have some real problems out there. So we are going to try to address some of the record keeping that might be necessary, along with looking at the structures.

We will hold the first seminar in Atlanta on February 22 through February 24. The second seminar will be in Denver on April 19 through April 21.

The seminars were very well received last year and I think we will try to follow the same format. Again, we will be in Atlanta February 22 to 24, and in Denver April 19 through 21. So hope to see some of you or your representatives there. Thank you.

Mr. Steele: Thank you, Joe and Bill. Our final Monday tally at the conference is 75 B&B; 133 Roadmasters; 266 suppliers; 96 guests, for a total of 570, and there's 98 ladies for a grand total of 668. So possibly tomorrow we can get a little over 700.

Next we will have John VanHuis introduce our final report on the Maintenance of Movable Bridge.

Mr. VanHuis: I would like to introduce Jimmy Neece, supervisor bridge and building for CSX. Jimmy received a B.S. degree in civil engineering from Tennessee Technological University in Cookeville, Tennessee. He has served as resident engineer, bridge inspector and assistant B&B supervisor and assistant project engineer before assuming his current position. Jimmy has been a member of the B&B Association since 1983. He is also a member of AREA, ASCE and ACI.

Special Subject No. 2

Maintenance Of Movable Bridge Machinery

Chairman: Jimmy Neece, Supv. B&B, CSX, Helena AL
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Movable bridges, also known as drawbridges, are bridges which the whole or a section may be drawn up, let down, or drawn aside to permit access for boats, barges, etc. Drawbridges have been in service on highways and railroads for over 70 years. Since that time the design and operating machinery of these bridges has not changed substantially. With a few exceptions, such as enclosed gear drives, solid state circuitry, and self contained lock-bar operators, the equipment installed on bridges 40 years ago does not differ noticeably from components installed today.

Movable bridges consist of three major types:

1. Swing spans
2. Vertical lifts
3. Bascule

The swing span bridge opens by rotating the movable span so it is in line with the channel. In the closed position the span is supported by three piers or bents. The pivot pier supports the weight of the span and the rest piers stabilize the span in the rest position.

The vertical lift bridge consists of a rigid horizontal span supported between two towers. The span is raised to allow boat traffic and lowered back into the rest position to allow rail traffic.

The bascule bridge is opened by rotating a leaf or leaves from the normal horizontal position to a point that is nearly vertical, providing an open channel of unlimited height for marine traffic.

Each type of movable bridge has a unique operating procedure. Therefore, each has unique machinery and maintenance criteria. For many years railroad personnel have had a paradigm concerning maintenance of movable bridge machinery. The old school of thought was, ‘If it ain’t broke, don’t fix it’. With today’s higher costs associated with replacement components, reduced manpower, and reduced budgets, preventative maintenance is a must for survival.

What is movable bridge machinery? The AREA’s chapter 15; Steel Structures part 6 – Movable Bridges, states that machinery includes the following:

Axles
Balance chains
Bridge locks
Wire Rope
Cranks
Hydraulic system
Racks
Sheaves/Drums
Wedges
Winding drums
Bearings
Brakes
Buffers
Couplings
Gears
Piston & cylinders
Shafts
Shoes
Balancing wheels

This is only a partial list. As you can see, the AREA's definition of movable bridge machinery would include every component of the bridge except the super structure and piers. Each item requires some type of maintenance in order for it to function properly. This maintenance can be as simple as injecting lubricant into a grease fitting to as complicated as removing the part and then servicing it.

Gear Maintenance

Typically there are two types of open gears used on movable bridge exposed gearing drives: spur and straight bevel. Spur gears are mounted parallel to each other so that they can transmit power between them. The bevel gears are mounted on shafts, and the shafts are mounted at an angle with one another usually at 90 degrees.

Spur gears are cylinders with gear teeth cut into the cylinder. Pinions are gears with smaller diameters. The pinion normally drives the gear except in a braking operation and the procedure is reversed.

Spur racks are flat straight bars with the teeth machined into the bar. Spur racks can be thought of as many segments with an indefinite radius. A section of this gear would be perfectly straight. A rack tooth profile would be the involute, curled or curved in, of a base circle with an infinite radius. Since such an involute would be a straight line, the racks would have straight sided teeth. These racks are commonly found on swing span bridges.

Alignment is a very important maintenance item for gears. If the gears are not properly aligned they will not transmit the maximum power with minimum wear.

The three most common alignment problems are:

1. Crossbearing
2. Radial alignment
3. Axial alignment

Crossbearing occurs when the rack and pinions are not parallel. Crossbearing is the loading of one face of the tooth on one end and the opposite face at the other end, resulting in a staggered pattern of end wear.

Radial alignment occurs when the center distances of the rack to the pinion are too great, or too small. Therefore, the teeth will not make full contact and do not engage to the proper depth.

Axial alignment results when the rack and pinion do not engage along their entire length. When this occurs the load is only carried by a part of the tooth.

Gear teeth are subjected to wear from many sources. Each type of alignment problem results in a distinctive wear pattern, but several other factors contribute to gear wear. Lack of lubrication, abrasive particles, poorly machined teeth, surface flaws and corrosion can contribute to tooth wear.

Proper lubrication is the number one preventive maintenance of gears. The frequency of the lubrication is dependent upon the amount of usage. Generally, the rack and pinion gears should be lubricated on a weekly basis. The rack and pinion should be cleaned with a degreaser to ensure that all grit is removed. Upon completion of this task, a good grade of open gear lubricant should be applied.

The bolts holding the rack itself should be checked weekly. If the bolts are not tight the rack can move and alignment problems will exist.

Bearings

Bearings are supports and guides for a rotating, oscillating or sliding element such as a shaft. The bearings provide an interface between rotating and non-rotating parts. In most movable bridges a shaft rotates while the bearing and its housing remains stationary. The major function of the bearing is to support applied loads, maintain alignment and minimize frictional power losses.

Sleeve Bearing

A sleeve bearing is a cylindrical sleeve that fits with a slight clearance over its associated shaft or journal. Sleeve bearings support both radial and axial loads. Radial loads are supported by the cylindrical portion of the bearing. The shaft is restricted from axial movement by the flanges on the bearing, which also bear, and axial loads imposed on the system. The distance between the bearing and the journal (usually .001 to .002 inches per inch of shaft diameter) is for the lubricant.

Split bearings are used frequently to facilitate assembly. This type of bearing can be found in areas where there would be difficulty in installation or removal. The only difference between a split bearing and one piece bearing is that the top is removable.

Maintenance requirements:

1. The bearings should be inspected weekly for cracks in the housings check tightness of bolts holding pillow block in place and check for corrosion.
2. Check clearance between bearing and journal with feeler gauges weekly.
3. Grease fittings weekly.
4. Remove bearing caps and visually inspect the journal and bushing for proper lubrication and the presence of abrasive or corrosive elements.

Center Bearings

Center bearings are the most critical wearing part and the most difficult to inspect on swing span bridges. A steel top plate is attached to the bottom of the span. It rests on the bronze top disc of the bearing and the bottom disc is located on the bearing base. The bearing base rests on the pier.

The top disc rotates with the span and the bottom disc remains stationary. Oil grooves are machined into the spherical surface on the bronze disc. The grooves will assure proper lubrication. An oil box is bolted to the bearing base to lubricate the disc by being submerged in oil contained in the box. The disc should be inspected periodically for excessive wear. This can be accomplished by :

1. Raising the bridge several inches and exposing the discs.
2. Testing the oil – Testing the oil for foreign particles would be the least labor intensive. This procedure would require comparing previous tests with current tests. If the oil samples reveal an excessive increase in foreign particles, then the bridge should be jacked up and the discs visually inspected.

Weekly maintenance of the center bearing should include:

1. Filling oil box and checking bolts holding box to the bearing base.
2. Checking for oil leaks around the oil box and all around the bearing base.
3. Checking tightness of anchor bolts at bearing base.

Trunnions

Trunnions have a rotation of less than 90 degrees, therefore, they can cause more problems than other bearings. Trunnions are no different than any other bearing as far as maintenance requirements. The trunnions should be lubricated weekly.

Balance Wheels

Balance wheel assemblies are mounted to the bottom of the span. The wheel bearings are located in the hub of the wheel and the shaft is stationary.

Weekly maintenance required for the balance wheels should include:

1. Checking the distance between the rail and the wheels. The distance should be the same for each wheel. The correct tolerance should be found on the design drawings.
2. Checking tightness of all bolts.
3. Greasing all fittings using lithium grease.

Shafts and Couplings

To transmit torque from one part to another, from a coupling to a pinion, from a coupling to a coupling, or from a gear to a pinion requires the use of shafts.

The main cause of shaft failure is cracks. Cracks usually begin in high stress areas such as a keyway or shoulder. (A shoulder is an area where the shaft diameter changes size.) Very often a keyway ends at a shoulder which produces a high stress area. Corrosion is another cause for shaft failure as well as severe shock loads. Either case will produce small cracks that will eventually grow into larger more serious problems.

The main type of maintenance on shafts is inspection. Shafts should be inspected monthly. The inspector should examine the shaft to determine if it is twisted. Occasional heavy loads will put a twist into the shaft. The shafts should also be examined for cracks. Small streaks of rust are usually tell-tale signs of cracks. Ultrasonic or radiographic inspection is an alternative means of inspection that can be used to detect cracks in shafts which are hidden from view. The use of magnetic particles and dye are also means of inspection. Both of these types of inspections may be beyond the capability of the normal maintenance crews.

Flexible couplings are used to prevent stress build up in the shaft and bearings resulting from misalignment. However, misalignment should be minimal. Shafts should be aligned as closely as possible when installed. Flexible couplings must have clearance between the shaft ends and also the hubs mounted on the shafts. The alignment cannot be corrected if there is no clearance.

There are three major types of couplings used on movable bridges: Gear, chain and grid.

Couplings maintenance should include the following:

1. Inspect all seals and gaskets. The sign of lubricant between the flanges will indicate a faulty gasket.
2. Check all bolts for tightness.
3. Annually the covers of the couplings should be removed and inspected internally for metal particles and lubrication contamination.
4. Lubricate couplings monthly.
5. Inspect for alignment of shafts going inside couplings.

Lifting and Locking Devices

End and center wedges (lifting and locking devices) are used to secure the span under live load. These devices are slow moving, sliding components which are exposed to contamination and weather. Therefore, they should not be overlooked. Lubrication and alignments should be checked weekly.

Wire Ropes

Wire ropes are one of the major machinery components of vertical lift bridges. Wire rope failures can be classified into three areas:

1. Fatigue
2. Abrasive wear
3. Abuse

Fatigue can be recognized by the appearance of small cracks in the individual wires. Fatigue is the result of repeated bending of the rope as it is wrapped around the sheaves or drums.

Abrasion is the result of foreign material such as sand, rust and corrosion.

Abuse is the result of poor maintenance - lack of lubrication.

Inspection is the number one maintenance item for wire ropes. The up-haul and down-haul, and the counterweight ropes should be inspected frequently. The inspection should include conditions of lubricant, checking for flattening or broken wires, slack, (slack causes the uneven raising and lowering of the span which will cause wear to the span guides) and the end attachments and connections.

Annually, the counter weight ropes should be evaluated to determine the relative load in each rope. The purpose of this evaluation is to determine if adjustments are needed. This evaluation will require mathematical computation of the tension in each rope.

Wire rope replacement should be made if inspections reveal broken strands, a reduction in diameter, corrosion, lengthening of lay or accidental damage. The proper length and diameter of the rope for replacement should be found on the design drawings. The length of the rope should include any requirement for the dead wrap on the drums and attachment fittings. The replacement rope should be ordered as per AREA article 6.6.10 entitled “Prestretching”.

Sheaves and Drums

The ropes connecting the span and counterweight pass through large diameter annular grooved drums called sheaves. The sheaves are mounted on trunnion bearings.

Operating drums are similar in appearance to sheaves and are mounted on the spans. The drums are grooved in a spiral fashion and rotate in a bearing assembly.

Sheave and drum maintenance should include the following:

1. Inspection of the grooves of sheaves and faces of drums for signs of rust and the appearance of abrasive particles.
2. Determine if there is any rubbing between the ropes and grooves.
3. Check alignment.
4. Top of the drums should be checked for symmetry.
5. Lubricate all bearings in sheaves and drums semi- annually.

Span Guides

Span guides keeps the vertical lift spans properly centered and restrain any excessive movements. The span guides are located on all four corners of the tower columns.

Maintenance of span guides consist of lubricating the guides. The frequency of lubrication will be dependent upon usage.

Balance Chains

During the lifting operation of vertical lift bridges the spans encounter an unbalanced condition. This is contributed to the weight of the counterweight ropes as they pass over the sheaves. Balance chains suspend from the counterweight and attach to the tower to compensate for the unbalance condition.

Maintenance of balance chains consist of inspection of pins and links and lubrication to prevent rust and corrosion.

Conclusion

The maintenance of movable bridge machinery generally is performed by B&B crews. The drawtenders perform daily maintenance such as tightening bolts, inspection of lift rails, span locks, maintaining motors, navigational lights and various other daily maintenance items.

The maintenance work performed on drawbridges must be performed with safety in mind. The safety of the employees, train movement and boat traffic can not be ignored.

The most detailed and meticulous maintenance program is only as good as the report that follows. The reports should include the name of the item maintained, type of maintenance performed, any pertinent measurements, general condition and date of maintenance. The purpose of this report is two fold:

1. It will ensure that preventive maintenance is being performed.
2. The report will establish helpful information concerning wear patterns.

The items covered in this report are only a small part of the maintenance items on a movable bridge. Each type of movable bridge and individual bridges will have their own unique maintenance requirements. The main criteria for a successful maintenance program is to plan, organize, direct and control. Have a plan, organize the plan, direct the plan, and control the plan.

REFERENCES

"BRIDGE INSPECTOR'S MANUAL FOR MOVABLE BRIDGES"
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

"LESCHEN WIRE ROPE"
SLINGS, FITTINGS, STRANDS
GENERAL WIRE ROPE INFORMATION
ST. LOUIS, MO.

"AREA'S CHAPTER 15"
STEEL STRUCTURES

"MOVABLE AND LONG-SPAN STEEL BRIDGES"
MCGRAW HILL BOOK COMPANY, INC.

President Walbrun: Thank you, gentlemen. Before we adjourn, I would just like to remind you all, once again, that we have the special subject cards for 1993 in the back of the room. Fill one out and keep in mind that it doesn't matter if you have a lot of information or a little information or if you are an expert, we want your input because this is the meat of what this conference is all about, your participation.

With that, I hereby adjourn this meeting until 8:30 tomorrow morning with the Roadmasters. Thank you.

Session adjourned.

TUESDAY MORNING JOINT SESSION

SEPTEMBER 22, 1992

President Walbrun: The second joint session of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America will now come to order.

Ladies and gentlemen, members and guests, on behalf of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America, I welcome you to the second joint session of this conference here in Chicago.

The registration this morning is 136 Roadmasters, 75 B&B, 266 Associates and 105 guests for a total of 582. With the 99 spouses in attendance, we have a total 681 registrants.

I have a couple of announcements this morning. The Bridge and Building Association will be repeating its very successful seminars on bridge inspection training. We will have two seminars, the first in February in Atlanta and the second during April in Denver. More information will be available in RT&S Magazine and direct mailings to all the members.

Next March, at the Palmer House, AREA Committee 24 will host a symposium on the preparation of bridges for 125 ton carloads. More information will be available in RT&S Magazine and direct mailing to all the members.

I also want to remind you that during the week of September 19, 1993, our conference will be held in Denver. We, and the Roadmasters, will be having our joint annual conference during the REMSA equipment show. Also scheduled at that time will be the AREA Fall meeting, AREA Committee 32 computer symposium and Transportation Research Board's regional meeting. We expect this one week extravaganza will probably be one of the largest rail show operations in the decade and maybe in the last 30 years. Please mark your calendars now because I think this will be one of the best shows we've ever had.

At this time I would like to turn the podium over to Steve Hill who will introduce our keynote speaker for this morning.

President Hill: Thank you, Mark. At this time I am pleased to introduce Mr. Neal R. Foot who is vice president and chief operating officer heavy haul, U. S. for CP Rail System. Neal was born in London, England, and he began his railroad career by working as a sectionman for CP Rail in 1966. He continued to work for CP Rail after graduation from the University of Western Ontario with a bachelor's degree in civil engineering. Neal has held many positions including assistant engineer, assistant division engineer, assistant superintendent, superintendent and assistant general manager until assuming his present position in 1990. In addition to his civil engineering degree he also holds a master's degree in business administration from Purdue University and is a member of the American Association of Railroad Superintendents, the American Railway Engineering Association and the Association of Professional Engineers of Ontario. Neal is a director of the Minnesota Safety Council, Indiana Harbor Belt Railway and the Kansas City Terminal Railroad. His topic for this morning will be "Market Driven Maintenance-of Way-Spending." I am looking forward to how much additional money he will be giving to our division (Laughter) and how we can justify future increases. Please join me in welcoming Mr. Foot. (Applause)

KEYNOTE ADDRESS

Market Driven Maintenance-of-Way Spending

Neal R. Foot

Vice President and Chief Operating Officer
Heavy Haul U.S., CP Rail System

Thanks very much, Steve. I'm somewhat of an unorthodox speaker and although I was given copious notes, you'll find that I ramble a lot and won't necessarily refer to all these notes all of the time. I wanted to start off this morning with a little bit of a story to set the stage for what I want to talk about. It seems that St. Peter was standing at the pearly gates one day and these three people walked up to him. It just happened that two were roadmasters and one was a B&B supervisor. St. Peter told them, "You know, there's no problem with you getting in. I'm going to let all three of you through the gates. The only problem I have is determining the order in which you're going to pass through. I want you each tell me how your work related to something in the Bible. The earlier in the Bible the reference then that's the order in which you'll pass through the gates." So the first roadmaster who had spent the latter part of his career involved in first aid said, "Well, you know, if you remember, when they created Eve they took a rib from Adam in the Garden of Eden. This was a surgical procedure. A surgical procedure indicates that the medical profession was obviously involved and the medical profession is tied right to first aid, safety, and therefore, my work goes right back to the beginnings." St. Peter said, "That's very good. I don't think anyone will be able to beat that." But the second person who was a bridge and building supervisor and who had done a lot of design work in his career said, "I think you have to listen to what I have to say. I realize that his was a great piece of work, but it took place in the Garden of Eden. The Garden of

Eden was a massive structure laid out using a lot of landscape architecture and this took plans and designs. This couldn't have been done without someone from my profession being involved. So obviously, mine is the earlier reference." St. Peter said, "That's true. That sounds very good." The third person stepped forward. Originally this person had been a marketing salesperson but had seen the light and had become a roadmaster. (Laughter) This person said, "You know, first of all I'm surprised I'm even here but based on my career and my vast exposure to marketing and sales I think that I have the earliest reference. If you think back to the very first line in the Bible, it says, "In the beginning before there was anything else there was chaos." And that was what I think most of us in the engineering profession thought of marketing and sales for many, many years. Chaos! (Laughter) I hope that today when I'm finished speaking that you'll think of marketing and sales in a somewhat different light and think of them as being very much involved in the business that we do today. The decisions that are made have to be market driven, have to be driven by the customer and very much driven by marketing and sales.

Today the large capital budgets we're spending are really a thing of the past. We saw many, many years where a number of companies were able to spend large capital dollars, large investments wherever they wanted. We could charge the customer whatever we wanted. The last few years we have been unable to do that. Now we have to put priorities on how we're going to spend maintenance-of-way dollars and make sure that those dollars are absolutely necessary in their spending. We don't foresee any large increases in volume, in traffic. It seems that most roads, I think, have pretty well reached a level of where we are in business. For some of the major roads there may be some large increases but most of the roads have reached their level. Our coal business has reached a certain level where we expect that it's not going to grow a tremendous amount and so there's no large growth in revenues. What we have to do now is start to manage our expenses and manage our capital investments. Certainly increased competition for business is going to mean tight margins on what we handle; the immense profits are no longer there.

Today, dollars don't automatically go to maintenance-of-way. In the past when we had a capital budget meeting most of the decisions were how we were going to spend the dollars in track, bridges and expenditures related to maintenance-of-way. That's not necessarily so today. Today dollars go where the best return is earned; where they're going to provide money and return money back to the company. Maintenance-of-way equipment and service improvements compete for a slice of that pie. In fact, marketing and sales has a greater influence over where we spend the money. Large maintenance-of-way budgets were also expected, I think, in the past by maintenance of way people. Many of us, and myself included, tended to go out and try to get the most money you could. You always ask for a little bit more. We always felt that the people who controlled the budget expected us to come in and ask for 125 or 130 or 150 percent of what we wanted and delighted cutting us back some. So we always inflated what we wanted in order to try to get a bit more so we could create a nice piece of track, a nice structure, a nice building or build a top notch facility. Now maintenance-of-way managers must justify the expenditures and start to stretch these dollars a little further. It's not enough anymore to say I want to build the best piece of track I can build; it has to be market driven. It has to be justified.

Historically, engineering, along with possibly transportation, made most of the maintenance-of-way decisions and where we were going to spend money. Marketing and sales more or less concentrated on equipment: what type of equipment should we buy? What should we lease, that sort of thing. That's changing very quickly. We really spend maintenance-of-way dollars for several reasons:

(1) To maintain a safe railroad
(2) To maintain the necessary communications and facilities on that railroad
(3) To meet the marketing and customer needs

Operations or engineering and maintenance-of-way sets the priorities for the basic safety and operating needs, but marketing and sales and the customer determine when we need upgrading or additional services.

In the future what you're going to see more and more is that influence of marketing and sales pushing over into the rest of the company as to where the dollars are being spent. The operations people, the maintenance-of-way people are going to control that last block, the basic level of maintenance that we have to do to maintain safety of operations, but the rest of the dollars are going to be decided upon through the company primarily driven by marketing and sales influence.

To start, the marketplace creates demand for service and it's the marketplace, the customer really, that creates the demand for service. In the past, so often we, and I even made the comment to an individual when I was talking at breakfast this morning, a customer would come to us and say, "We'd like to get a shipment." And we would say, "Sure. Here's our train schedule, here's our service. You build the siding and the loading dock and then we'll handle your goods and we'll get them there at this time of the day." Today, it's turned right around and our customers, the marketplace, demands what type of service we will provide.

We can no longer expect to get a customer's business by dictating to them. The customer's business plan or the company's business plan drives expenditures, both one year, five year and longer cycles. Maintenance-of-way spending must coincide with the levels of business we expect to achieve. I think all of us will recall an example of where we invested in a particular building, upgraded a piece of track or put in a signal system only to find out two years later that the traffic on that line had declined. No one bothered to check the business plan to find out if the companies who were shipping on that particular stretch of track were still going to be there in two years' time or five years' time. If, for example, a coal mine was there, and we only looked at the very short term and said we handle so many tons over that track it should have 132 pound rail, 136 pound rail, whatever and it should have such and such number of ties renewed per mile to keep up to the tonnage. But if we didn't bother to look forward into the contract of that company hauling that coal to see if there was only a two or three year contract, where were we going get that business in two or three years' time? Should we invest in that line? Should we maintain it to the level we've been maintaining it for the last five, ten or 15 years?

Customers today want the railroads to be innovative and to be prepared to handle goods in new ways in the future. They look for companies who are willing to invest in the future up front and that means share the investment many ways with the customer. The customer often comes to us and says, "We're thinking about building a plant. We're thinking about building a facility. We're not too sure yet where we want to build it. If we build it in your area or on your lines what would you bring to the party? Would you be prepared to invest in building a track into the facility? Would you be prepared to invest in a loading dock? Would you contribute towards some of the equipment that we're going to use to haul the product? These are things that, in the past, the customers didn't push on us. This was customer investment. Our investment was strictly related to the railroad. Now we're looking at bridging the gap between the customer and the railroad in order to get the business. In many cases we have to do it just to retain the business.

Today railroads must manage their assets and put them where the return is best. Non-performing assets must be re-deployed. What I mean by this is that in many cases in the past we had a worn-out shop and we would decide that it had reached the end of its useful life. So we would put in a capital request and replace the shop. We did that with many facilities and I use the shop only as an example. Today, we have to look at "is that facility really in the right place". It's not just that it's worn out so therefore we replace it where it is any more. We have to look at the business. Is the business that we want to haul in the future dictated by that location? In many cases in the past the building was there because that happened to be the end of a train crew run or where we maintained locomotives, but do we really want to do that there in the future. It's not a matter of just saying the facility is worn out. What we have to say is the facility is worn out, do we replace this one or do we go somewhere else and build a new one? Are we going to go to inter-divisional run in two or three years time and if we are, then it doesn't make a lot of sense to build the facility in the middle of that inter-divisional run today just because it's worn out and in three years' time we'll have this wonderful facility but no one using it. It's this kind of forward thinking that we have to start to use when we're doing planning and tying it to the rest of the business.

Here are just a few examples. This is Cottage Grove, our automobile compound in St. Paul. It's a case of where we must supply the facilities, we must supply the service and we must supply the capital. The customer comes to us and says we want to ship automobiles. If we're going to retain that business we have to invest. That's a marketing and sales decision in the sense that this company provides good revenue. It provides a source of cash to do the other maintenance-of-way projects necessary, but we have to invest dollars in this facility in order to make money.

There has to be a balance between equipment and service. This is supposed to look like a scale but it doesn't look too much like one. What we have on one hand is maintenance-of-way spending and on the other hand is car equipment. Obviously we have to be able to have cars to haul merchandise. It may not be hopper cars like this, it may be intermodal cars, but we have to be able to serve the customer. In most cases it's nice to get new maintenance-of-way equipment and we need some of that in order to maintain the facility but there is a tradeoff here. We have to understand that when we buy a new tamper or a new liner that, in fact, is capital dollars that could have been spent to buy new equipment to ship more customer goods. So we have to be sure that we balance that off. It's not a decision that's made in isolation but rather a decision that's made together as to what's the best use of our capital dollars.

We have to work more closely to examine how we invest in projects to improve service. As I said before, some business is assured. We sometimes know that we have a shipper who is captive to our lines. They can't go anywhere else. They ship bulk commodities in large amounts and we've kind of got them. That's the exception in most cases. Sometimes we build now because we feel that some future business may result, we're hoping that we're going to get an investment. Sometimes there's a downside. In other words, if we don't participate we won't get any business. There's risk involved in what we do today.

As I pointed out earlier, if we do not build, if we do not invest, we just won't get the business. The rail, ties and ballast you see going in here could be going in the main track somewhere, but if they go in the main track somewhere we won't get that business. So there's a tradeoff that has to be made. In many cases, marketing and sales has to be instrumental in making that tradeoff.

Doublestack tunnel clearances are something that I think all railroads are familiar with. On CP Rail System we have been doing a lot of work in the last year or two to insure that we can handle doublestack containers from the west coast, Port of Vancouver, to the eastern Canadian markets in Toronto and Montreal and to the markets in Chicago. Hopefully, by late this year or early in the spring we'll be offering a doublestack service from the west coast into the Chicago area. But that's kind of a leap of faith. We're putting money into this project, enlarging tunnels, on the presumption that we're going to get business. We've worked very closely with marketing and sales on this to justify that investment. Many people, traditionally in our business and in the operating side and maintenance-of-way side, would have asked why we are doing this? "Why enlarge these tunnels? They're perfectly good tunnels and have been there for 150 years, we don't need to do this." Obviously we have to do it if we're going to get the business so it's really a leap of faith. The business isn't there today but if we're going to get the business in the future, going to be successful, going to get the revenues and generate the cash that's going to provide money to invest in the main track, we have to do this sort of thing.

Trans-load facilities are very, very much in style today. Our marketing people are often coming to us and saying, "We have to have $100,000 to build this concrete pad or this fenced in area because we're going to trans-load lumber, or coal or potash or something in this facility. This is an example of what would have, in the past, traditionally been a customer loading dock that was built with railroad money so that we could ship combines and farm implements. What, in fact, happened in this situation was that we operated unit trains with the customer. We got them a complete unit train of farm implements and ran them to a ship to send overseas. But we invested in the facility, again competing with the dollars that normally go into the track, and provided a good return to the company.

This is a coal unloading facility, obviously a big investment by the railroad in order to get the business. If we hadn't invested, the coal unloading facility might have been built a few miles away and we wouldn't have been in there. Again, this is money that didn't go into the main track, didn't go into the facilities that we wanted it to go into, but it had a good impact on the company.

Industrial development is another area where marketing and sales is putting dollars into helping customers locate facilities. This is an anhydrous ammonia facility that generates cash for the company. That's very important to us, but we had to invest dollars to build this facility otherwise we wouldn't have gotten the business. Again, it took money away from the track but put it into another facility.

Trackage rates investments. This is a picture of a train operating between Detroit and Chicago on CSX. Today, all of us in the railroad business know very well that we operate trains on each other's tracks. Many times we say to ourselves and I've particularly heard many of our maintenance-of-way people say, "I don't understand why we don't keep our own track. Why are we selling that piece of track, it's a perfectly good piece of track. We could keep it and get all the revenue. Instead we're going to tear our track up and go over some other railroad." Well, the reason is because working together with another railroad, we can share the investment. We may not have enough traffic base to be able to maintain 150, 250 or 500 miles of track, but together with one railroad, or even perhaps two railroads, we can share the capital investment needed to keep that piece of track up and we won't reach capacity even with all our volumes combined. Again, it's a decision that has to be made with marketing and sales because traditionally we've always been afraid that if we go on another railroad's piece of track, the customers are going to identify with that railroad. They'll identify with CSX not with CP Rail System in this case, therefore, if they're going to ship over part of CSX why not ship over all of CSX? Why not originate it on their railroad and terminate on their railroad? Well, it's something we have to decide very closely with marketing and sales, but in many cases it makes a lot of sense to do this sort of thing. It's called co-production in some areas and companies, but trackage rates is very much an important thing in trying to control capital investment.

Something I think we're going to see much more of in the future and we certainly see quite a bit of it in the midwest now is rail-truck-barge warehousing. It's where our marketing and sales people are working in conjunction with other modes of transportation to provide a total package to the customer: To be able to move the product from the warehouse, which may be accessible by truck, to the river, which is accessible by barge, to a trans-load facility where we can get it to the rail and then finally the destination or maybe even to another trucking facility where we can offload it again and get it back into the customer's hands. This requires a lot of help from marketing and sales to get these things done, but it also requires capital investment at the trans-load facilities and working with the other carriers. It's money, again, that competes with maintenance-of-way dollars. The dollars going into these trans-load facilities are not going into the track, not going into the structures, but they're necessary for the company to maintain a good business base, a good market base. Again, marketing and sales are very much instrumental in what has to take place in this area.

Branch lines. This is one of our branch lines in Iowa and what we call our core lines. As you can see, this is a large facility on what we would call a moderately maintained piece of track. If any of you stood closely and looked at the track next to the one the train is on, you'll see a pretty shoddy piece of track in some people's mind; poor cross level, the joints are going up and down. It's maintained to a level that's safe for the operation on that piece of track. The speed limits are designed to meet the FRA criteria and to handle the traffic that we handle. There are many people who would say that we need to upgrade this track, but in today's environment we have to maintain this track at a level that protects the investment. We move traffic on that line, we make money on it but all we really handle on that line are grain products and we can only input enough cash so we still get some return out of it. So, in many cases, we could go in and upgrade. We could go in and put rail in there. We could justify putting ties in there, but we only put in enough to maintain it to the level that we have to. Some people would say "since we're going to have a tie gang there anyway, why don't we go in and put 1,000 ties in or 1,500 ties to the mile." We may only go in and put 400 ties to the mile or 500 ties to the mile because that's all the investment will sustain. We work very closely with marketing and sales to make sure that we keep in touch with what the business is, how much the volume is going to be, what we expect the crop here to be like next year, so that we maintain it just to the level where we keep the operation safe but we don't over-invest in the line.

I have some tips here for becoming a better or smarter maintenance-of-way manager. These are things that I think are essential if we're going to be successful as a company and meet the competitive pressures that we're going to be under in the next few years.

Know the business plan. Know what the company wants to achieve and where business is expected and where it isn't. In other words, get to know your marketing and sales people. There are a lot of local representatives, a lot of other people; get to know them. Get to know what's in the plan. What's going to happen to the business on that line. What's going to happen to the contracts that we have today. Is the tonnage going to stay at the same level or is it going to drop off or increase? What should I be thinking about as a maintenance-of-way manager when I'm looking at next year, two years, three years ahead. Tie it to what's actually happening, what's actually projected in the marketplace.

Plan your maintenance of way spending accordingly. Put the dollars where they pay the best return. Don't overlook safety, but don't gold plate where there is little payback. We still have, and I think every company can point to some people like this, maintenance-of-way managers who want it because someone else has it. "That person got 20 miles of rail last year, it's my turn this year. I deserve the 20 miles of rail. My guys work just as hard as everybody else and if I can get the rail, you know I've got less maintenance, particularly if it's CWR replacing jointed rail, and it'll be easier for my guys. I'm not going to have all these broken rails to change and things like that." That sort of thinking has to be put on the back burner. What we have to think about is, does the marketplace require the investment? Can we get the thing going? Can we keep it going for a few more years? Is it money wisely spent if we invest in a customer facility this year and get more business on the line and put off the maintenance-of-way spending for a year or two, always keeping in mind that we have to keep the operation safe. We have to keep pushing the derailment expenses down and eliminating that type of thing. We can't overlook safety, but at the same time we can't gold plate. We can't just have money because someone else has it.

Use your assets wisely. Use what you order and don't overstock. In the past, many of us have tried to keep something in the weeds back behind the tool shed so that if it happens "I have that frog or the stock rail that takes a little while to get and I can put it in and get my piece of track back in service and keep the slow orders off." Most of us today are working with automated inventory systems and it makes it a little more difficult to do that, but it should still be in our minds that it's not to our best advantage to do it. You're not trying to beat the inventory system or the individual. What you're really doing is harming the company because you're buying material that doesn't need to be bought today. It could be bought six months from now or next year. So don't overstock, don't try to hide things because it isn't in the company's best interests. That cash could be spent doing something for another maintenance-of-way facility or for a customer facility.

Realize that maintenance-of-way costs are part of a total service package. Equipment may be needed, turning equipment can save costs, delaying cars costs money. You know, when we see cars sitting around, that costs money. Whenever a car comes in and sits for three or four weeks because someone is waiting to unload it, that's not a wise decision. Sometimes we look at it and say we don't have the people to do it today. That's something you really have to keep in mind because those cars, if they're not hauling maintenance-of-way equipment unless they're in a dedicated maintenance of way fleet, could be hauling revenue. We have to keep that in mind.

This is, I think, where we're going today and in the future. The customer creates the need, marketing and sales defines the need, and maintenance-of-way makes it happen. I would like to close with the idea of teamwork. I heard someone once say that "it's not I or you, it's not we or they, it's us." I think, more and more in the future, we have to think of that as a team concept. If we're going to be successful in the competitive marketplace that we're in, we can no longer think in terms of how much money are we going to get to spend this year? How much money are we going to get to invest and let's make sure we get more than they get. We have to think of it as a team concept. This industry has to compete against many other forms of transportation and if we, as an industry, are going to be successful we have to be sure that we spend our money wisely, that we invest properly and that we don't overinvest in any area of the company. I leave you with that. It's a team concept and marketing and sales is very much a part of that team. It's not the chaotic thing that I opened with and used as an example. There are many people today in marketing and sales who are very, very aware of what's going on in the field. They are very, very aware of what each of you is doing on a day-to-day basis and are trying to make decisions and influence decisions in our companies so that we spend our dollars wisely. So remember that. It's a team. Get to know your marketing and sales people. Get to understand that the decisions are business driven, not driven by the fact that we're trying to build the best plant we can ever build, but the fact that we're going to build the best business that we can ever build. Thank you. (Applause)

President Hill: Thank you, Mr. Foot. You certainly pointed me in the direction I need to go in my budget submissions from now on. (Laughter) The key, I think, is learning the language. Engineers have never really known the right language and now we're seeing how critically important it is for us to get involved with the marketing people and learn to speak their language. Learn how to work together. That's very critical.

I understand that you have other commitments, but if your time permits please feel free to spend as much time with us as you can and sit in on the rest of the presentations we have to offer here today.

At this time I would like to turn the podium over to Don Steele who will introduce this morning's first special feature. Don.

Mr. Steele: Thank you, Steve. Our first special feature this morning is on a topic that concerns us all and that is slope stability issues for railroads. Paul Tarvin, who is with STS Consultants, Ltd. from Milwaukee, Wisconsin, is a consulting geotechnical engineer with over 10 years experience. Paul received his BA and MS degrees at Michigan State University. He is a registered professional engineer in Wisconsin, Virginia, Maryland, New Jersey and Washington, D.C. Paul is an associate engineer with STS Consultants, Ltd., in their Milwaukee office, where his duties include directing both geotechnical and construction services departments in addition to acting as a project manager on several projects. Paul.

SLOPE STABILITY ISSUES FOR RAILROADS

Paul A. Tarvin, P.E.
STS Consultants, Ltd.

and

Alan B. Wagner, P.E.
GAS & Associates, Inc.

Introduction

This presentation addresses the mechanisms of potential failure of slopes, how slopes are analyzed to determine their stability and suggests possible remedies to avoid or remediate potential failures of railway embankments. In no way is this to be considered an exhaustive discourse on the subject of slope stability. Instead, it serves to introduce several general concepts regarding the stability of embankments. Individuals having specific slope stability problems are encouraged to contact a geotechnical engineer having familiarity and experience with the soils in the local area.

Stability Considerations

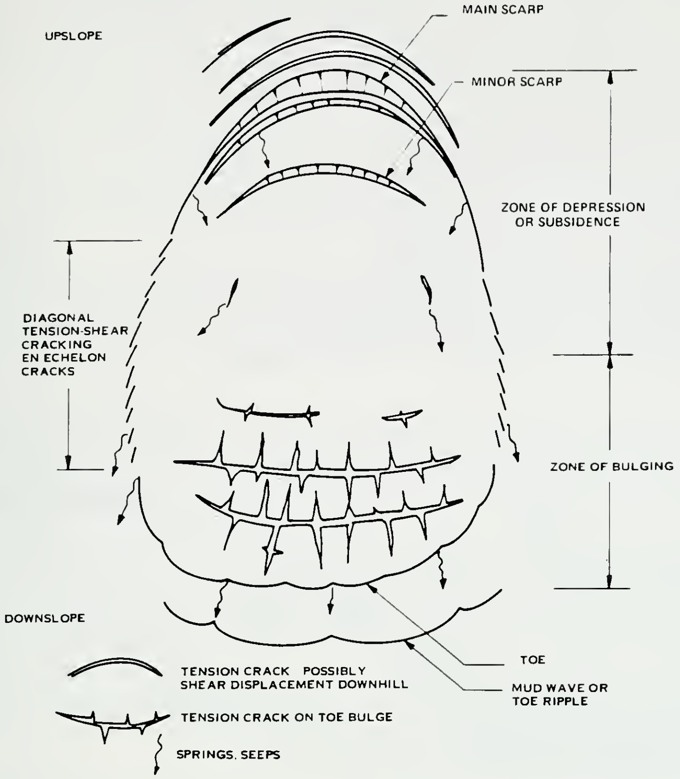
Earthen slopes or embankments usually fail in one of two modes: along a circular arc or along an inclined or horizontal plane. The former usually occurs in a relatively homogeneous soil mass. The latter failure typically occurs along a relatively weak soil stratum or in a weak seam in rock. Figure 1 identifies some typical features of a slope failure and the nomenclature used to identify these pertinent features.

This example is that of a rotational failure which occurred at an industrial facility located on Zug Island in Detroit, Michigan. The area in which the failure occurred was used for storage of raw materials. The raw materials were stockpiled to such a height that caused the foundation soils to become overloaded, thus resulting in a rotational type failure. Interestingly, the failure occurred adjacent to a river channel such that, when the failure occurred, a mass of soil was pushed out into the channel, which required subsequent dredging to restore the channel.

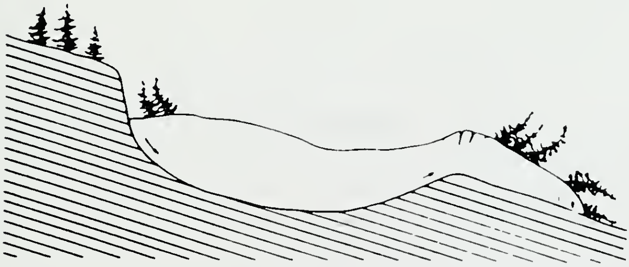
These examples show a wedge type failure occurring along an inclined plane. The edge of the failure, or the "escarpment" extended to the very edge of a pair of tracks which were the main lines of the local railroad. The failure occurred along a former steep natural embankment which had been filled in an attempt to improve the stability. Corrective measures were applied, which included regrading the slope, and installing a series of trench drains, to effectively lower the local groundwater table and to improve drainage.

The likelihood of a slope or embankment failure is usually expressed by a factor-of-safety. The factor-of-safety is the ratio of the forces or moments resisting failure to those causing failure. A factor-of-safety of 1.0 means that failure is imminent. It is fairly well accepted in the profession that a reasonable factor-of-safety for transportation related slopes and embankments is 1.5. However, this is not a hard and fast number because the value selected for a particular project should consider several factors, such as the following:

- The consequences of a failure
- The quantity of soil and groundwater information
- The variability of soil and groundwater information
- The quality of soil and groundwater information


UPSLOPE
MAIN SCARP
MINOR SCARP
ZONE OF DEPRESSION OR SUBSIDENCE
DIAGONAL TENSION-SHEAR CRACKING EN ECHELON CRACKS
ZONE OF BULGING
DOWNSLOPE
TOE
MUD WAVE OR TOE RIPPLE
TENSION CRACK POSSIBLY SHEAR DISPLACEMENT DOWNHILL
TENSION CRACK ON TOE BULGE
SPRINGS, SEEPS

PLAN VIEW



CROSS SECTION

FIGURE 1: NOMENCLATURE USED TO IDENTIFY FEATURES OF A SLOPE FAILURE

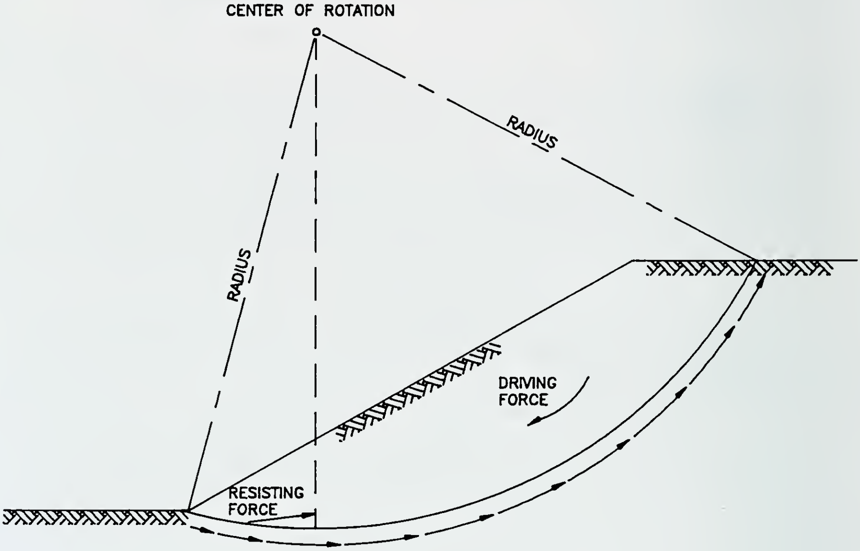


FIGURE 2: MECHANISMS OF SLOPE FAILURE

- The amount and quality of soil properties determined from laboratory and field tests
- The accuracy of topographic survey information

Factors-of-safety between 1.0 and the minimum value that is appropriate for a specific project means that some remedial measures should be taken to increase the factor-of-safety to that minimum value, or the slope should be closely monitored to determine that no movements are occurring. Additionally, factors-of-safety less than about 1.5 normally results in gradual creep movements that require significantly more maintenance work to prevent functional failure, even if absolute failure is not a concern. Factors-of-safety less than 1.0 means one of two things: (1) the embankment has not yet failed, but still may; or (2) the soil strength parameters or other factors were not well defined, resulting in a conservative analyses. Figure 2 shows a marginally stable slope, illustrating the concepts of the driving and resisting forces described above.

It should be kept in mind that the cost of constructing a slope or embankment is related directly to the factor-of-safety. In other words, the higher the required factor-of-safety, the higher the potential cost to construct the embankment. Therefore, it is important not to be unreasonably conservative, i.e., there needs to be a balance between safety and cost.

Methods of Analysis

Most geotechnical engineers analyze slope stability by computer programs, such as a program called STABL that was developed in a joint effort of the Indiana Department of Transportation and Purdue University. This program can analyze both circular arc and planar (sliding block or wedge) types of failure surfaces.

Before computers, slopes were analyzed for stability by dividing the slope into segments, assuming a trial failure surface through the slope, and calculating the resultant factor-of-safety. This process proved to be time consuming, and even after that effort, it was possible that the assumed failure circle was not the most critical circle, i.e., the one that would yield the lowest factor-of-safety.

By using computers, engineers can now analyze literally hundreds of assumed failure surfaces in seconds, once the computer model is created and programmed. Typically, it is good practice to perform manual calculations to confirm the results of the critical failure surface.

Hypothetical Slope Model

For the purposes of illustration, two hypothetical slope models were established: (1) a natural slope model; and (2) a constructed slope model. It was assumed that the natural slope was a side slope of a river valley, as is illustrated by Figure 3. This slope has an inclination of 3 horizontal: 1 vertical, and a vertical height of 40 feet. For simplicity only two soil layers were modeled: a two foot thick layer of topsoil over homogeneous clay that extends quite deep. This profile is relatively common in east central Wisconsin.

The constructed slope model considered the effect of constructing a horizontal bench, wide enough for two sets of tracks, about midway up the slope. This model is illustrated in Figure 4. It was assumed that this bench was constructed partially by cutting into the natural hillside, such that the slope above the bench was steepened to 2 horizontal: 1 vertical and partially by placing the excavated soil below the bench, such that the lower slope was steepened to 2 horizontal: 1 vertical. It was also assumed that the topsoil fill layer was left in place on the lower slope, and the fill was simply placed over it with little or no compactive effort. This simulates the earthwork procedures that were used on a recent slope project with which the authors were involved. Proper earthwork procedures are discussed later in this paper. Due to the poor fill compaction, it was assumed that the strength of the fill was equal to that of the topsoil. The soil strength parameters for both models are given in Table 1.

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TABLE 1 - SOIL STRENGTH PARAMETERS

		STRENGTH PARAMETERS			
		Total Stress Method		Effective Stress Method	
Soil Layer	Description	c (psf)	ø(degrees)	c' (psf)	ø'(degrees)
1	Topsoil	500	0	50	24
2	Clay	1500	0	200	28
3	Clay Fill	500	0	50	24

Slopes are typically analyzed for both short term (undrained or total stress) and long term (drained or effective stress) loading conditions. The undrained condition occurs in a cohesive (clay) soil when the load applied to the soil is resisted primarily by the interparticle attraction, or cohesion, between the soil particle. The drained condition results when the load is resisted primarily by the friction between the soil particles. Either type of analysis is appropriate for a cohesive (clay) type soil. When the soil profile consists of granular (sands and gravels), only a drained analysis is necessary.

In either case, but particularly for a drained analysis, it is critical that the long term position of the water table is reasonably well defined. In addition, if there are any confined water tables which may result in excess pressures in any of the soil layers, it is important to define their location and the confining pressure(s). This usually requires the installation of groundwater monitoring wells and piezometers.

For all of our hypothetical cases discussed subsequently, the assumed soil strength parameters resulted in the effective stress, or drained, approach yielding the lower factor-of safety.

Results of Analyses

Twelve cases, two involving the natural slope and ten involving the constructed slope, were analyzed. Figures 3 and 4 show the configurations of the natural and constructed slopes, respectively. The constructed slope analyses considered several variables; among them, total (undrained) and effective (drained) stress strength parameters, normal and artificially depressed groundwater, the presence and absence of loads from any trains, and circular arc and sliding block failures were analyzed. A concise summary of the variables and the resulting factors-of-safety is shown on Table 2. A brief description of the results follow in the subsequent paragraphs.

Natural Slope

Case 1 – Due to the homogeneous soil conditions it was considered likely that a circular arc failure would occur through or near the toe of the slope. The origin of the failure arcs was limited to this region. Figure 5 illustrates the numerous (100 in this case) failure circles that were analyzed by the computer. This figure also gives an idea of the wide-ranging area that was covered by the analyses. Figure 6 shows the ten most critical circles, while Figure 7 represents the most critical circle. Similar output was produced for each analysis, but is not included herein due to space considerations. The analysis indicated that the slope would have a factor-of-safety of 2.1 using total stress (short term) strength parameters.

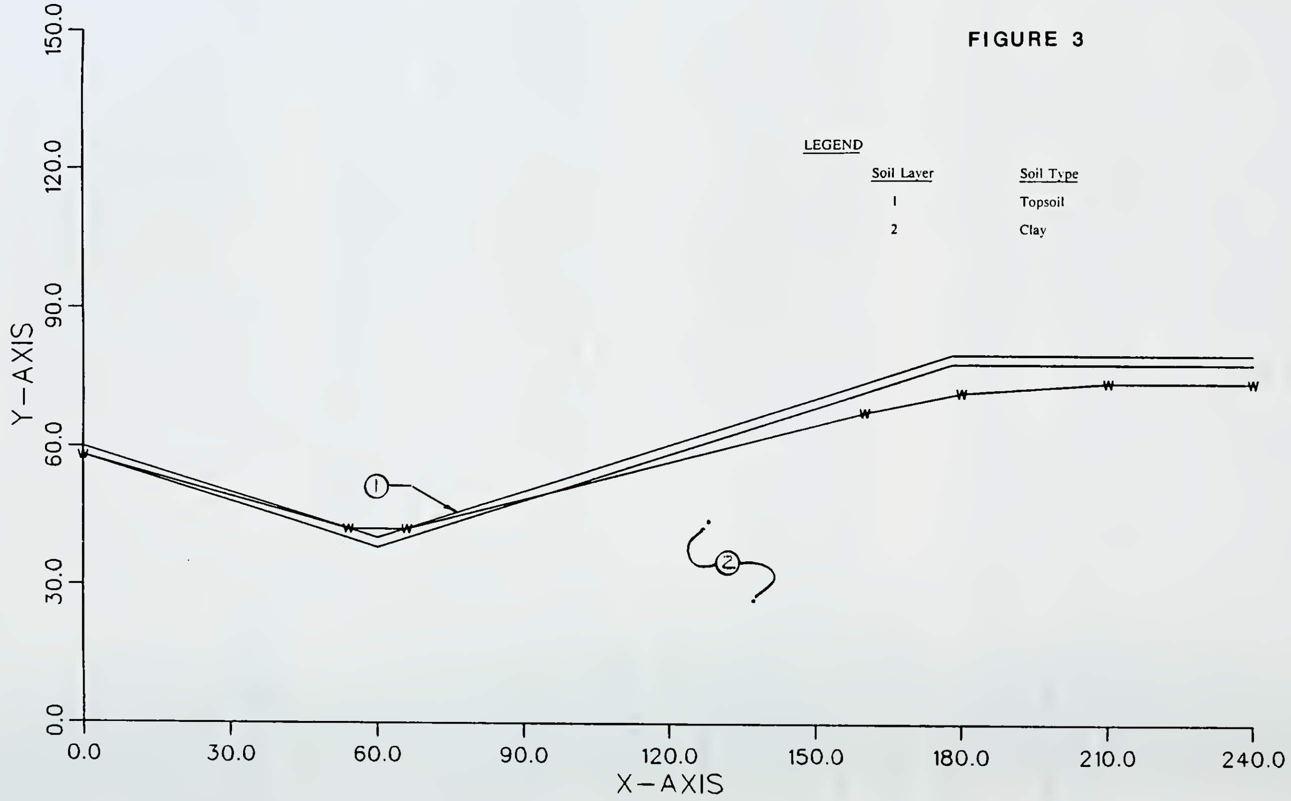
Case 2 – This case is the same as Case 1, except that effective stress strength parameters were used. The resulting factor-of-safety was 1.5, the minimum value that would be considered satisfactory. Figure 8 illustrates the critical failure circle for this case, which is similar in location to the circle in Case 1.

Constructed Slope

Case 3 – This case analyzed the overall (as opposed to local) slope stability, using total stress parameters. The groundwater table was in its assumed static long term (or normal) position following regrading of the slope. No train surcharge load was considered. A circular arc failure surface was analyzed. The resulting factor-of-safety was 2.3. This is slightly higher than the factor-of-safety for the natural slope, using total stress parameters. The reason for this is that in regarding the slope, weight was removed from the "driving" side of the center (radius point) of the failure circle and was added to the "resisting" side. This is an important concept that will be discussed in more detail later. However, while the overall slope stability is increased by this modification, the local slope stability may be jeopardized due to the steepening of the slope.

NATURAL SLOPE MODEL

FIGURE 3



CONSTRUCTED SLOPE MODEL

FIGURE 4

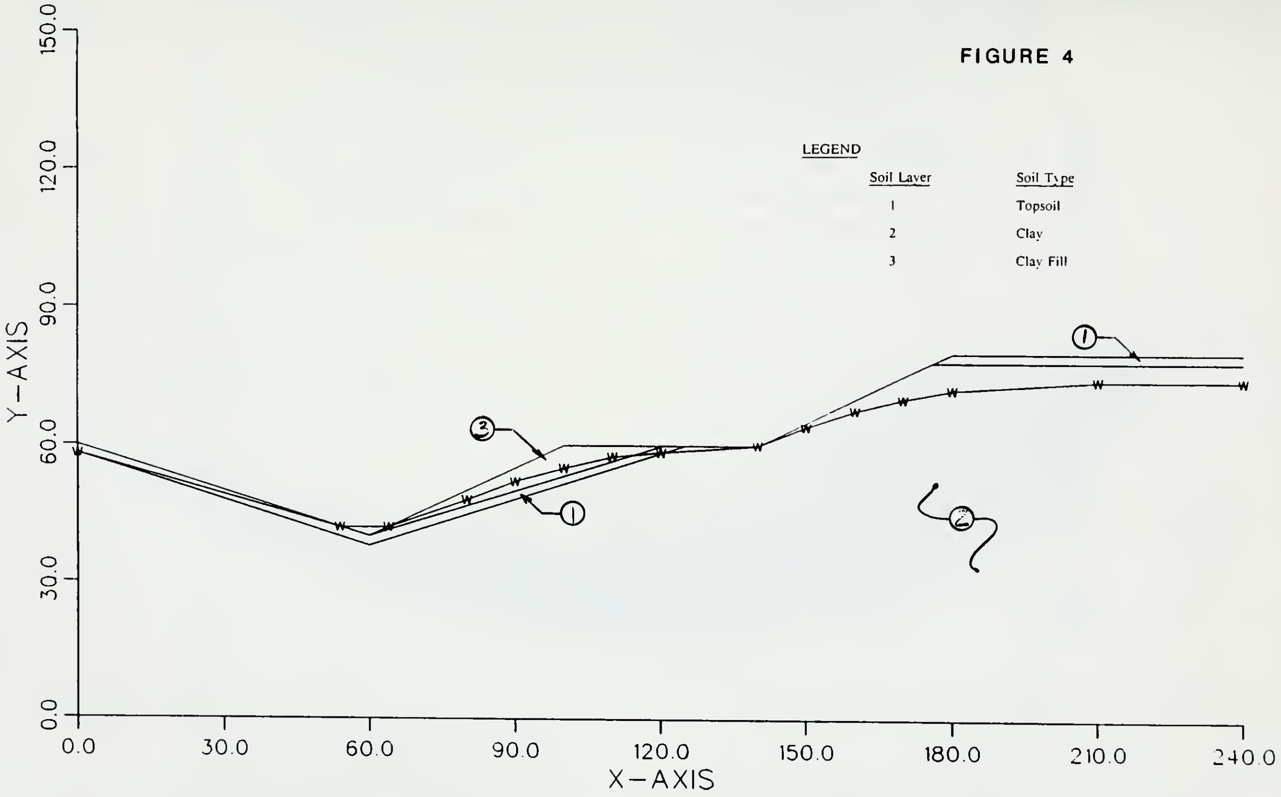
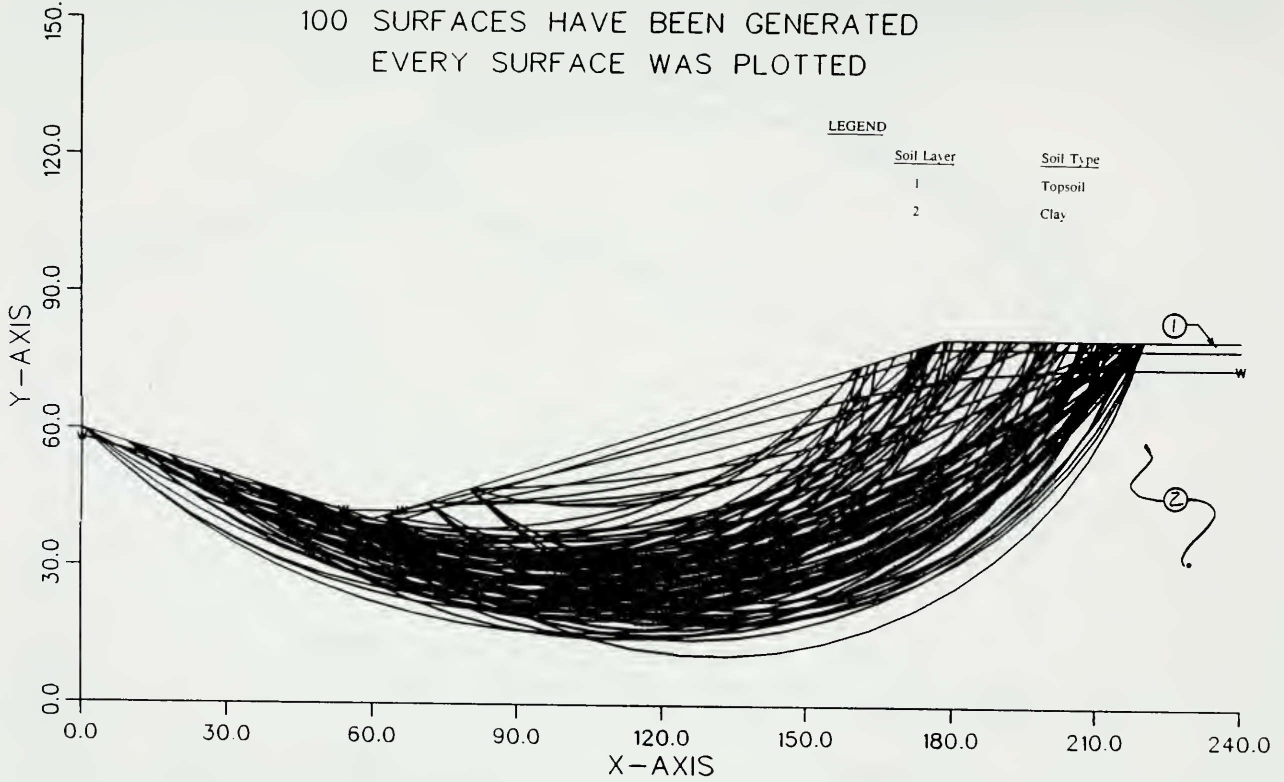


TABLE 2 - ANALYSIS DESCRIPTION AND RESULTS

CASE NO.	NATURAL SLOPE	CUT - FILL RR BENCH	TOTAL STRESS ANALYSIS	EFFECTIVE STRESS ANALYSIS	OVERALL SLOPE	UPPER SLOPE	LOWER SLOPE	NORMAL GROUNDWATER	LOWERED GROUNDWATER	NO SURCHARGE LOAD	RR SURCHARGE (2 TRACKS)	CIRCULAR ARC FAILURE SURFACE	BLOCK FAILURE	FACTOR OF SAFETY
1	●		●		●			●		●		●		2.1
2	●			●	●			●		●		●		1.5
3		●	●		●			●		●		●		2.3
4		●	●				●			●		●		3.5
5		●		●			●	●		●		●		1.1
6		●		●			●	●			●	●		1.1
7		●		●			●		●	●		●		1.3
8		●		●		●		●		●		●		1.7
9		●		●			●	●		●			●	1.3
10		●		●			●		●	●			●	1.6
11		●		●			●	●			●		●	1.2
12		●		●			●		●		●		●	1.4

CASE 1 - NATURAL SLOPE

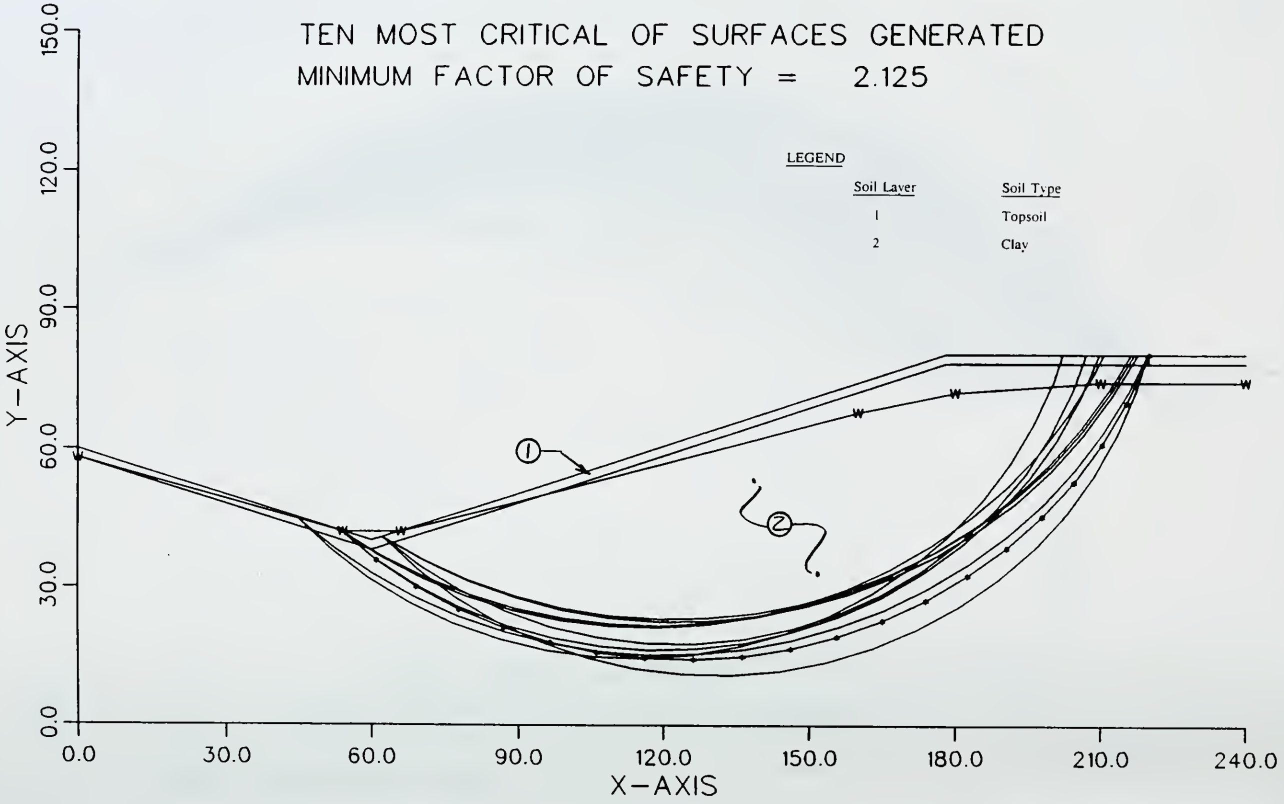
FIGURE 5



CASE 1 - NATURAL SLOPE

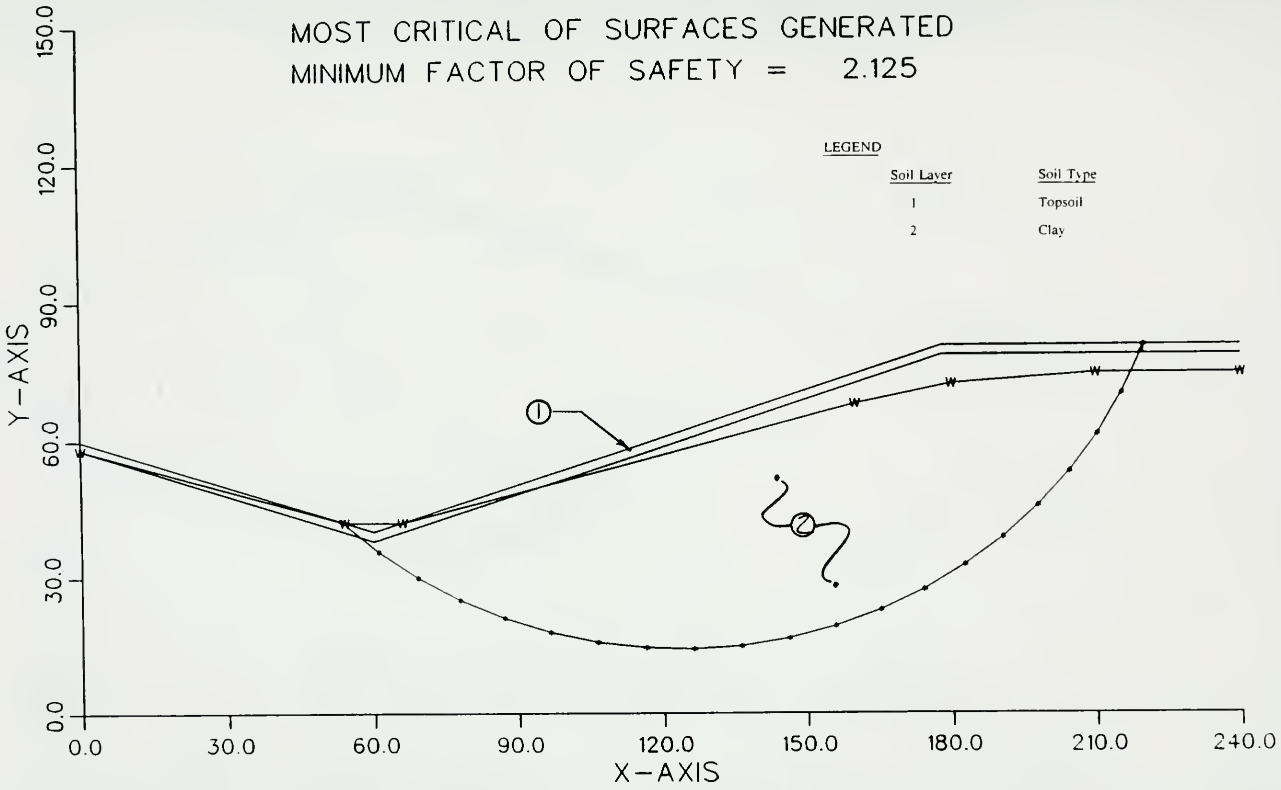
FIGURE 6

TEN MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 2.125



CASE 1 - NATURAL SLOPE

FIGURE 7



CASE 2 - NATURAL SLOPE

FIGURE 8

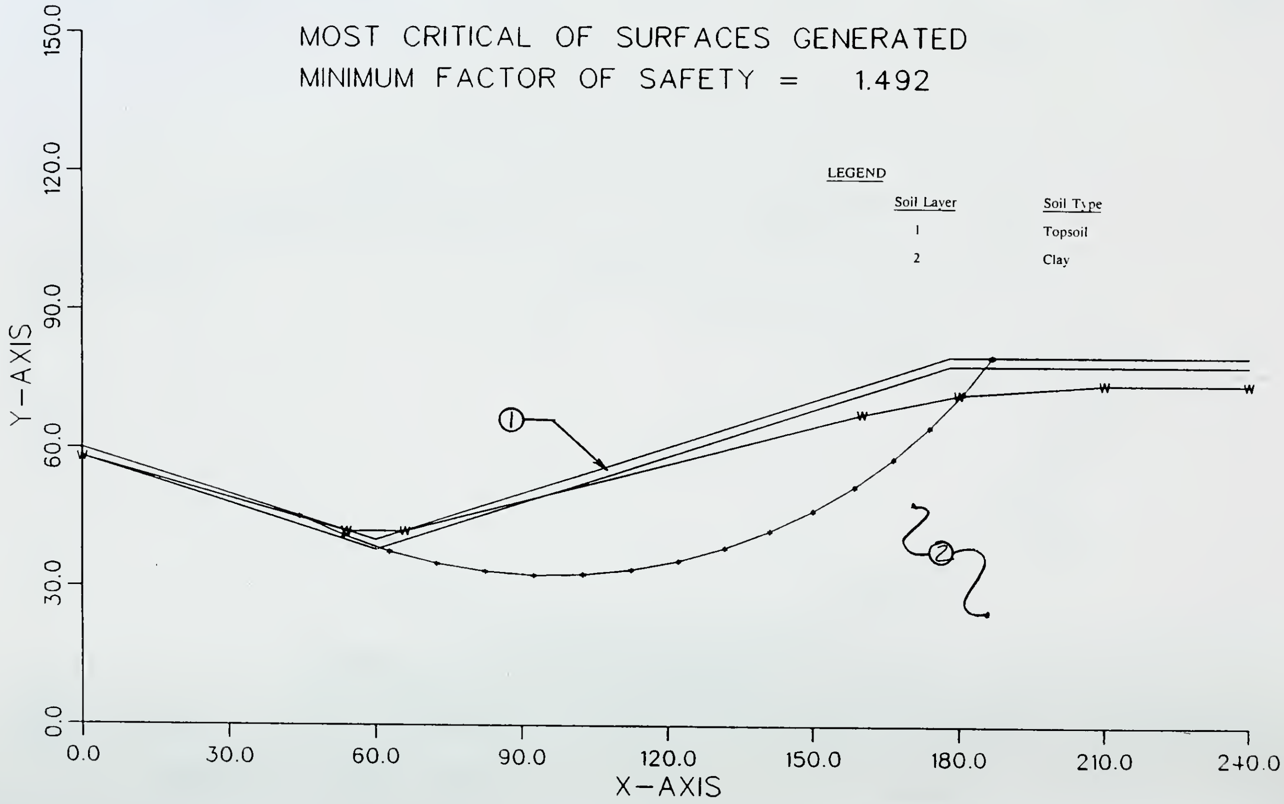
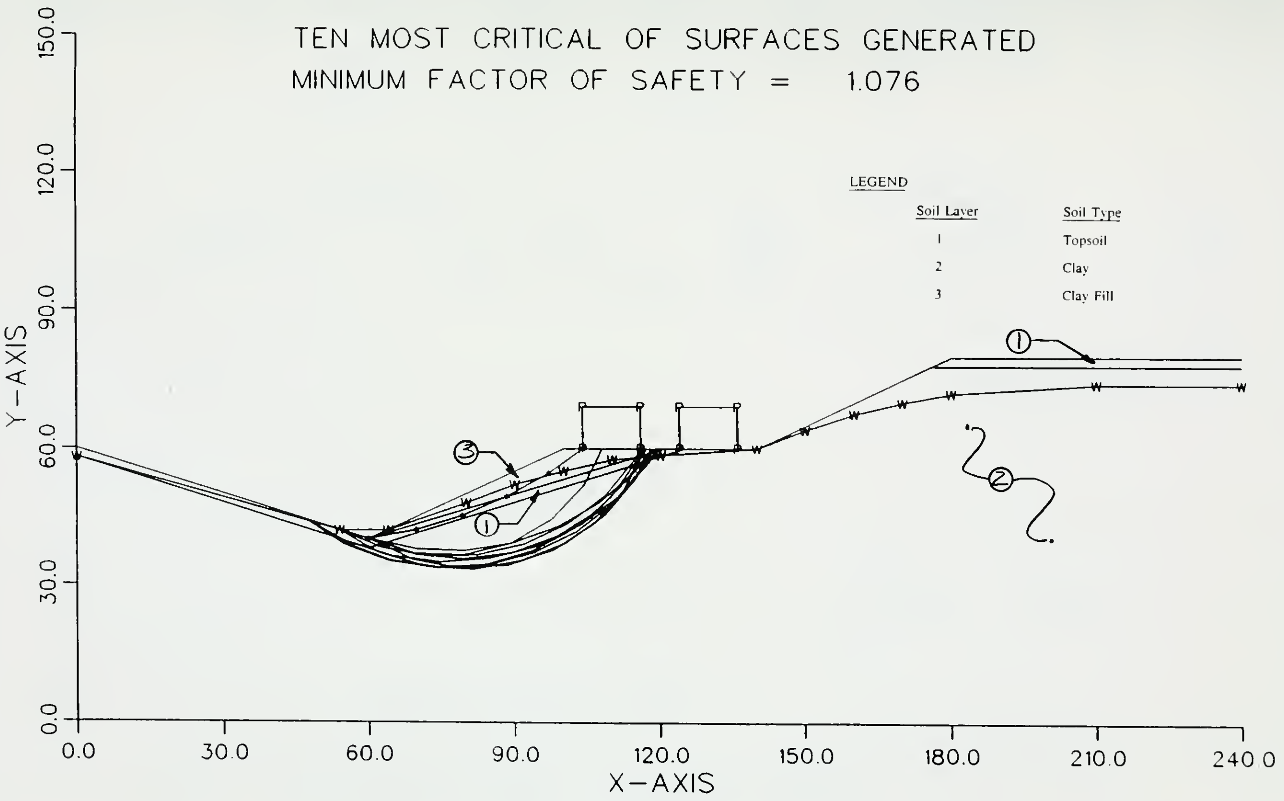


FIGURE 9

CASE 6 - CONSTRUCTED SLOPE WITH TRAIN LOADS



CASE 7 - CONSTRUCTED SLOPE WITH TRENCH DRAINS

FIGURE 10

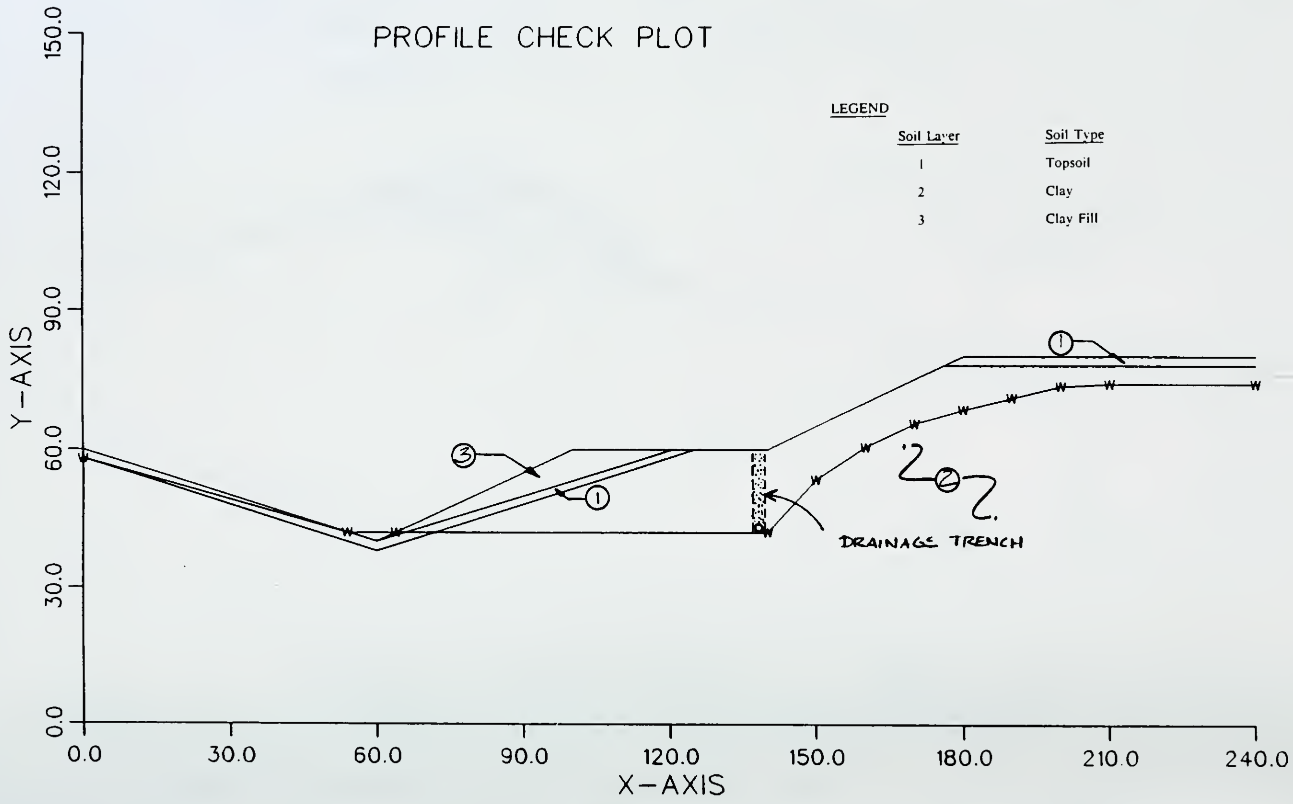
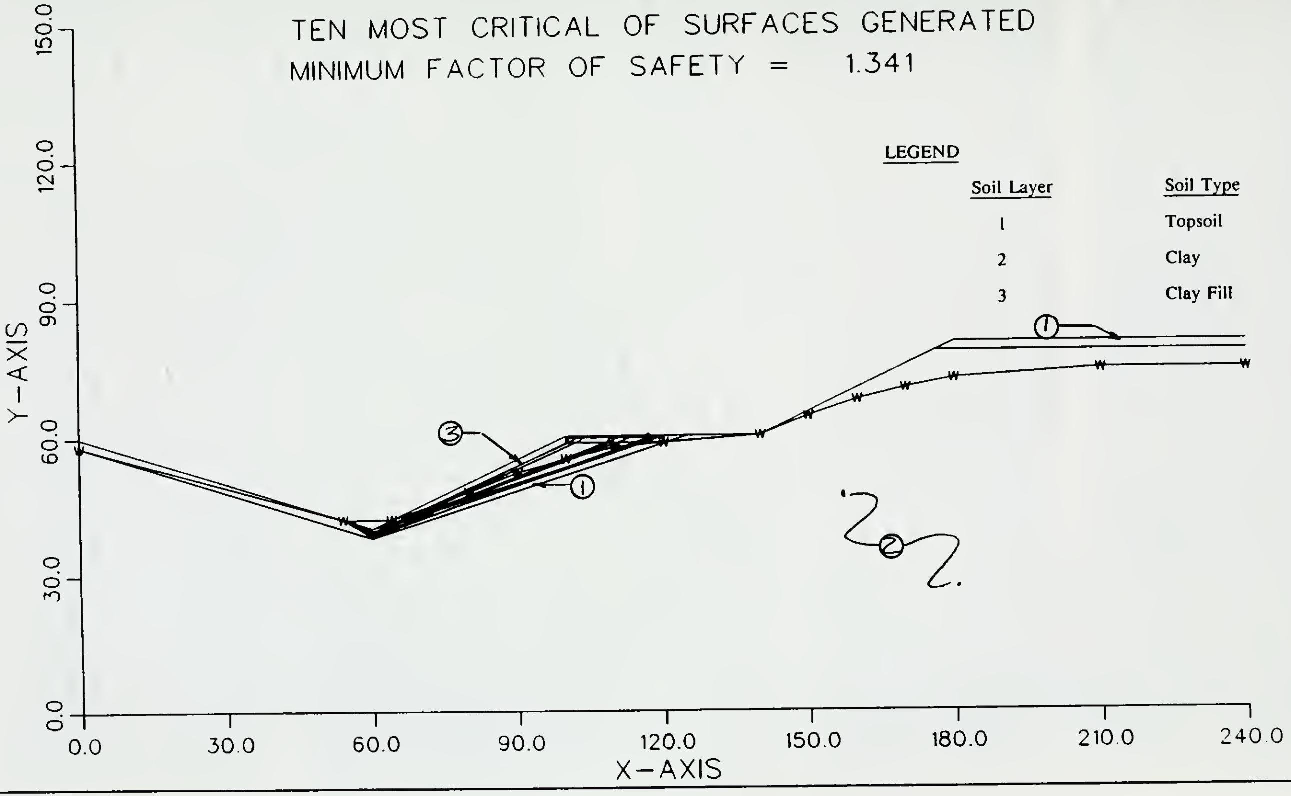


FIGURE 11

CASE 9 - CONSTRUCTED SLOPE

TEN MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.341



Case 4 – This case evaluated the local slope stability in the area of the steepened lower slope, again using total stress parameters. All other variables were the same as Case 3. The resulting factor-of-safety was 3.6.

Case 5 – This case analyzed the local stability in the area of the steepened lower slope. All variables were the same as for Case 4, except that effective stress strength parameters were used. The resulting factor-of-safety was 1.1, which is well below the desired minimum value of 1.5. This result indicates that remedial action would definitely be required, such as the installation of trench drains to lower the groundwater table and improve drainage, or construction of a berm or some slope reinforcement, such as drilled shafts or piles, to increase the resistance to failure.

Case 6 – In this case all variables were the same as in Case 5, except that surcharge loads from train loads on both sets of tracks were considered. The train surcharge load was assumed to be 1000 psf, which was based on Cooper E80 locomotive loading. Interestingly, no reduction in the minimum (critical) factor-of-safety resulted, because the critical failure circle intersected the horizontal bench on which the tracks were located to the left of the nearest track. However, from a review of the nine next most critical circles it was noted that the factor-of-safety on a similar circle was reduced from 1.6 to 1.3 as a result of the surcharge load. The ten most critical circles can be seen on Figure 9. The most critical circle intersected the horizontal bench just to the right of the left-most set of tracks. The reason for the higher factor-of-safety is that this particular circle extended deeper and intersected the stronger native clay soil. The point of this is that, as would be expected, the train surcharge load reduces the factor-of-safety for any circle on which the trains apply load.

Case 7 – This case considered the improvement that could be gained by depressing the groundwater table to increase the effective stress normal to the failure surface. No train surcharge was considered. Therefore, this case is exactly like Case 5, except for the groundwater lowering. The groundwater table in the area of the critical lower slope was assumed to be lowered to the level of the water in the nearby creek.

This could be accomplished by excavating a trench, parallel to the alignment of the tracks, at the right end of the horizontal bench, placing a drain line in the bottom of the trench and backfilling the trench with a freely draining granular solid. The drain line would be hydraulically connected, such that it could drain by gravity to the creek. This is the same concept that was used to improve the stability of the slope for the project illustrated here. Figure 10 illustrates the concept of the drainage trench. It should be noted that the drainage trench would not have to extend as deep as shown to provide somebenefit, since the trench, as shown would depress the water table well below the critical circles.

The improved drainage resulted in increasing the factor-of-safety from 1.2 to 1.3 for the hypothetical model. This value is certainly an improvement but still is less than the 1.5 value that would be desired. Therefore, additional remedial efforts would be required to raise the factor-of-safety, or additional monitoring of the slope would be warranted.

Case 8 – This case looked at the localized stability of the upper slope, using effective stress parameters. The groundwater table was assumed to be in its natural position and, of course, no train surcharge loads were applicable, since this slope is above the horizontal bench that supports the tracks. The calculated factor-of-safety was 1.7, which is considered adequate.

Case 9 – This case was the first case that considered a planar rather than circular failure surface. The analysis was based on effective stress strength parameters, the natural groundwater position and no train surcharge. The ten most critical surfaces generated for this analysis are shown on Figure 11. The critical factor-of-safety was 1.3, which is greater than the factor-of-safety for the circular failure surface but is less than the desired 1.5 minimum value.

Case 10 – The Case 10 model was the same as Case 9, except that the groundwater table was assumed to be lowered by a drainage trench as was discussed previously for Case 7. The depression of the water table increased the factor-of-safety from 1.3 to 1.6.

Case 11 – Case 11 was the same as Case 9, except that a train surcharge load was added to the horizontal bench. This load reduced the factor-of-safety from 1.3 to 1.2.

Case 12 – This case considered the effect of lowering the groundwater table, as in Case 10, but adding the train surcharge load, as in Case 11. The resulting factor-of-safety was 1.4, which, as expected, is lower than the factor-of-safety for Case 10, but higher than the factor-of-safety for Case 11.

General Slope Remediation Considerations

The analyses discussed above provide a background for discussing what can be done to increase the stability of an existing slope that is experiencing problems. In general, there are two measures than can be taken to increase the stability of a slope: (1) decrease the driving force that is causing the failure or, (2) increase the resisting force.

The driving force can be reduced by removing weight from the area contributing to the problem. This concept is illustrated in Figure 12. This, in most cases, would be difficult to accomplish. Removing soil obviously would typically result in lowering track grades which could have impacts up and down the line. Also, removing soil could improve the stability in one area, but adversely affect the stability in another area, perhaps further up the slope, if excavation resulted in steepening the slope there.

In most cases, it is easier (not necessarily easy, but easier) to increase the resisting force. In the case where a circular arc failure is critical, weight (soil fill) could be placed on the downhill side of the circle's center (radius point). Figure 13 illustrates this concept. Again, this could potentially reduce the localized factor-of-safety further down the slope, so this procedure should only be considered after carefully evaluating any negative impacts.

As discussed in the above examples, depressing the water table can increase the effective stress in the soil acting normal to the failure surface, thereby increasing the friction on this surface. While groundwater control can lead to an increase in factor-of-safety, as seen in two of the above cases, the increase, by this method alone, may not be enough. Therefore, additional remedial measures may have to be taken.

Another method of increasing the resisting force is to install rigid shear elements across the failure surface. One way of doing this would be to drive piles or install reinforced drilled shafts on a grid pattern. This concept is shown in Figure 14. A consideration with this method of remediation would be the strength of the soil relative to the shear element. If the soil is very weak, it may tend to "flow" or creep around the piles or drilled shafts, rather than engaging the full shear capacity of the elements. The number of shear elements required to increase the stability can be engineered, based on the deficiency in resisting forces indicated by the computer analysis. Another consideration is the effect the vibrations caused by driving the piles may have on a marginally stable slope.

Another type of shear element that is less rigid is a stone column. A stone column is typically constructed by drilling a hole, backfilling it with coarse angular aggregate that is compacted by a vibroflot or another type of compactor. In this case the shearing resistance is provided by the friction among the angular stone particles. Consideration should be given to constructing a clay cap over the stone columns to prevent groundwater recharge from surface water inflows into the stone columns.

Loose granular soils can be improved in place, in some situations, by a procedure often referred to as deep dynamic compaction or, less glamourously, as "ground pounding". This method typically involves dropping heavy (generally in the 2 to 10 ton range), flat bottomed weights from significant heights (generally in the 30 to 100 foot range). This method should be used with care around slopes, since excess pore water pressures can be built up that can temporarily reduce, rather than improve stability. Deep dynamic compaction is probably

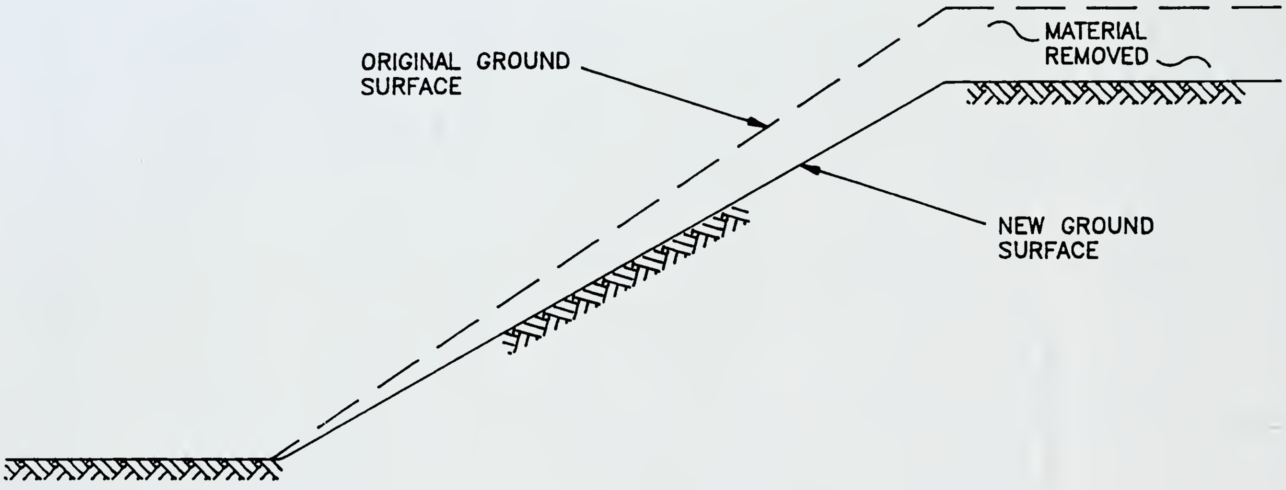


FIGURE 12: IMPROVING SLOPE STABILITY BY REMOVING SOIL WEIGHT

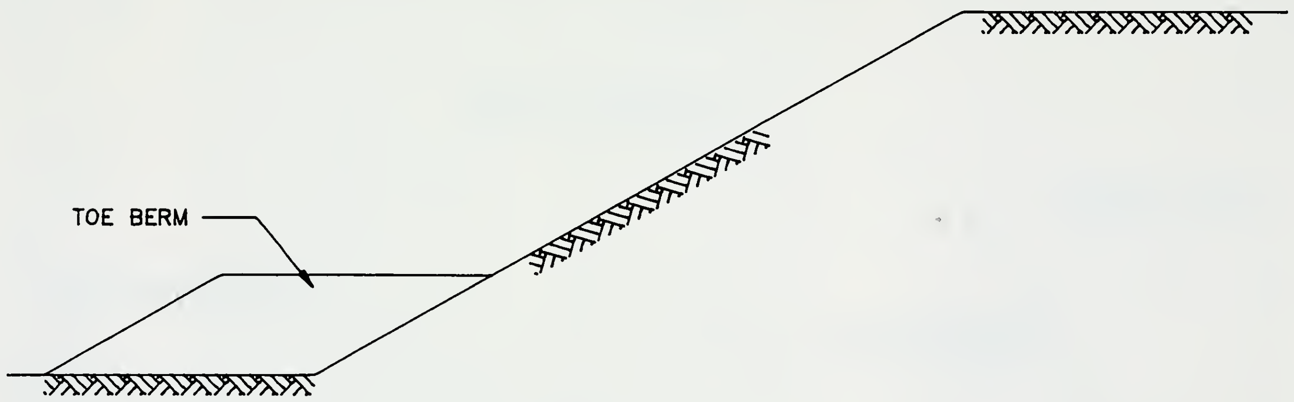


FIGURE 13: INCREASING SLOPE STABILITY BY CONSTRUCTING TOE BERM

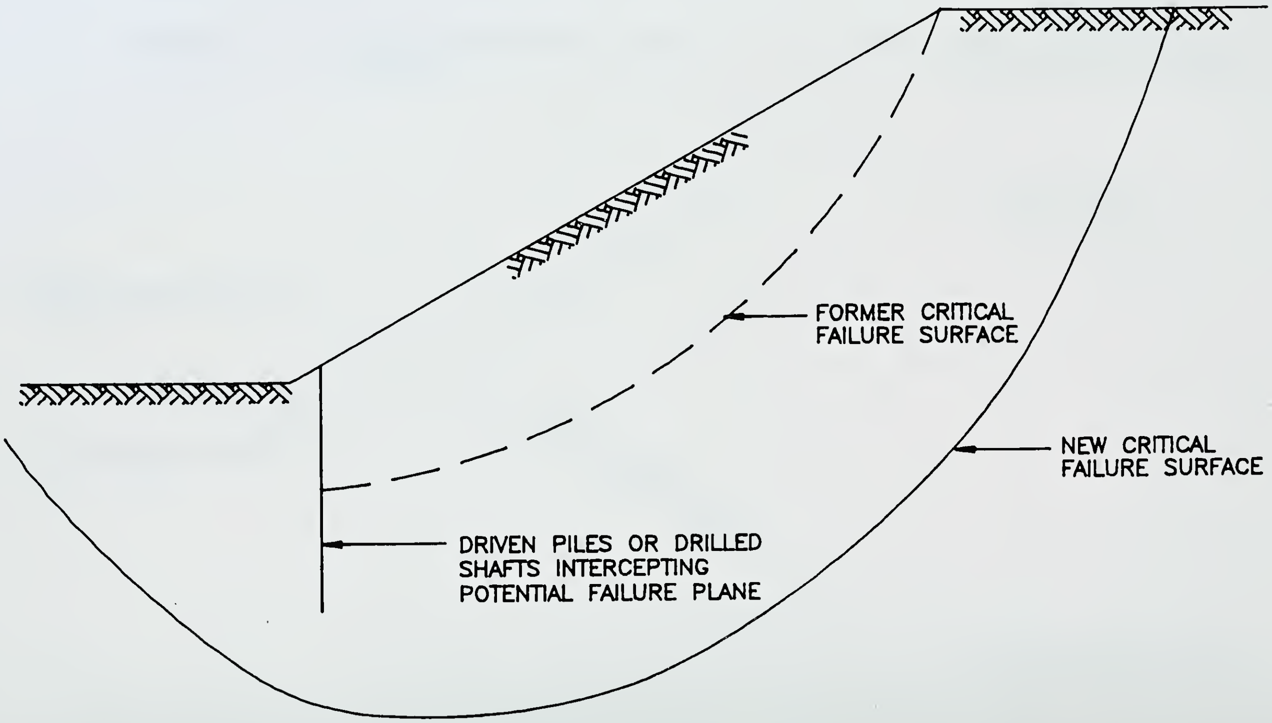

FORMER CRITICAL FAILURE SURFACE
NEW CRITICAL FAILURE SURFACE
DRIVEN PILES OR DRILLED SHAFTS INTERCEPTING POTENTIAL FAILURE PLANE

FIGURE 14: INCREASING SLOPE STABILITY BY DRIVING PILES OR DRILLED SHAFTS

most applicable to improving foundation soils where a new embankment will be constructed over loose granular soils.

Additional resisting force can also be applied by providing geosynthetic reinforcement in a slope. However, in general this method is usually most applicable to the construction of new slopes, which is beyond the scope of this article. Geosynthetics generally serve two purposes in a constructed embankment. The first is to act as a separator between the natural subgrade soils and any newly placed fill. Secondly, and perhaps more importantly, the geosynthetic fabric can provide additional strength to the foundation soils to allow them to carry the additional weight, thus resulting in a more stable embankment. One project near West Bend, Wisconsin, involved constructing a ten foot high highway embankment over up to 22 feet of weak, highly compressible peat. It was determined that over $400,000 was saved on that project by leaving the peat in place. Although the reinforcement prevented a slope failure, it did not prevent settlement from consolidation of the organic soils due to the weight of the embankment. We predicted about three feet of settlement within six years of construction. That embankment was constructed six years ago and has performed as expected. This settlement has occurred, but has not caused any functional problems, since the differential settlement between the edge and center of the peat bog occurred very gradually over a long distance.

Early Warning Signs

There are several early warning signs that one can look for potential slope instability. In general, most natural slopes are typically stable at slopes flatter than 2H:1V. Therefore, if there are slopes along the alignment which may appear as steep or steeper, additional investigation may be warranted. This could be as simple as reviewing the U.S.G.S. Quadrangle map for the area, checking the topography, and confirming the steepness of the slope. A visual reconnaissance of the area should be made to check for signs of movement. The rail alignment should be viewed for signs of shifting or other movements. If there are any trees on the face of the slope, check to see if they are growing vertically, or if they are tilted. Trees not growing at or near vertical would be an obvious sign of ongoing movement, or of movement which may have occurred in the past. The area near the crest of the slope should be checked for signs of tension cracks. Tension cracks are typically the earliest signs that the slope is at least marginally stable.

Water seepage from the face of the slope can also be an early warning sign of slope instability. Seepage can be an indication of shallow or perched groundwater, or possible water under pressure, which could adversely impact the stability. If these signs are evident, the installation of groundwater observation wells or piezometers may be warranted.

There are several methods available to monitor ongoing or unsuspected movements. The most common way to check for slope movements is to install a device called an inclinometer. An inclinometer includes a plastic or metal casing which is installed in a borehole on the face or near the toe of a slope. A measuring device is inserted into the casing, and the deviations from the vertical are calculated. One can measure the magnitude of the lateral movement and the depth at which the movement is occurring with an inclinometer. Other types of instrumentation include extensometers and strain gauges. However, these devices require special equipment to monitor the instrumentation and provide measurable, meaningful and reproducible results.

New Construction

Giving exhaustive recommendations for constructing new slopes and embankments is beyond the scope of this article. However, a few comments are appropriate. Taking shortcuts in constructing slopes and embankments, such as not stripping topsoil or other weak soils, not cutting horizontal benches to reduce the potential for slides on the inclined contact or not placing and compacting soil fill in a controlled fashion, can expedite construction and save initial construction dollars. However, almost invariably, this approach leads to problems with long term performance and much greater life-cycle costs. Although up-front costs may be higher, properly engineering slopes and embankments usually result in lower life-cycle costs and far fewer maintenance problems. Thank you for your attention. (Applause)

Mr. Steele: Thank you, Paul. Darrell Cantrell will introduce the next speaker.

Mr. Cantrell: Our next speaker is Mike Roach and he is chairman of standing subject No. 1 which is “Environmental Issues Facing Maintenance of Way Supervisors.” Mike is director of environmental protection for the Norfolk Southern. He received his B.S. degree in civil engineering from Virginia Tech. Mike has held positions of assistant environmental engineer, environmental engineer, supervisor environmental engineering and manager environmental protection. He is a member of the Roadmasters and Maintenance of Way Association, the AREA and NSPI.

STANDING SUBJECT NO. 1

Environmental Issues Facing Maintenance of Way Supervisors

Chairman: F. M. Roach, Jr., Dir.Env.Prot., NS, Roanoke VA
Committee: J. C. Dodge, Reg.Mgr.Rdwy.Mtce., AT&SF, Kansas City KS
B. A. Craiggs, Rdm., BC Rail, Vancouver BC
A. S. Uppal, Mgr.Brs.&Strs., CN, Edmonton ALB
T. A. Price, Rdm., CP Rail, Medicine Hat ALB
D. W. Clark, Mgr.Engr.Mtce., UP, St. Louis MO
V. R. Terrill, Terrill Trk.Cnstltns., Manchester MA
N. Calton, Envr.Engr., BN, Springfield MO
D. Marshall, Sls.Coord., Century Precast, Rockford IL
R. L. Meinzer,Reg.Engr., Contech, Topeka KS
G. A. Foster, Engr. M/W, KCT, Prairie Village KS
R. Kale, Envr.Engr., Soo Line, Minneapolis MN
J. M. Smith, Prod.Mgr., SynTechnics Inc., Paducah KY

Society's concept of preservation of natural resources did not become a reality until the late sixties and early seventies. At that time, Pittsburgh and Los Angeles were choked with smog, rivers in industrial areas were choked with waterborne pollutants. The Federal government answered the public's call and told us not to pollute the air in 1970, not to pollute the water in 1972, not to pollute the land in 1976, and to go back and clean up our old messes in 1980.

Then came the eighties. The spoiling of vast reaches of pristine wilderness with oil, hypodermic needles and human waste on beaches, and entire communities permanently abandoned as the result of incorrect disposal of hazardous waste, heightened public consciousness of the greening of America. Governmental agencies again answered the public's call with the tightening of existing regulations.

The general public of today has developed an increasingly more intense and far-reaching interest in the environment. Federal state and local governments have answered the public's mandates for protection of the environment with extensive and, sometimes hard to understand, regulatory measures.

The most significant environmental regulatory measures impacting the railroad are:

1. The Clean Water Act (CWA)
2. The Clear Air Act (CAA)
3. The Toxic Substances Control Act (TSCA)
4. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
5. Resource Conservation and Recovery Act (RCRA)
6. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA – Superfund)

Environmental Concerns

Today's maintenance-of-way employee has a responsibility to himself, his family and the general public to protect the environment. Like most railroad employees, maintenance-of-way workers must pay attention to the environmental consequences of the day-to-day operations which they control. Day-to-day operations can and do involve compliance with all of the listed regulations.

The Clean Water Act

Under the Clean Water Act industry cannot discharge, or cause to be discharged, any pollutants into surface waters or sewers without a permit. To get a permit you must be operating from a fixed facility. Most permitted wastewater discharges on railroads are oil/water separators. These oil/water separators clean up the water using gravity. The oil floats to the top and the suspended solids such as sand and dirt settle to the bottom. The treated water leaves in the middle.

Unfortunately, there are no means of monitoring or controlling dangers to the water and general environment from the mobile employee such as the track gang, the B&B gang, the signal maintainer. Responsibility for the actions and environmental concerns generated by these men and their machines must fall squarely on the shoulders of line management. Maintenance-of-way employees must not release materials such as oils, solvents, paints or solid materials into the streams or sewers no matter how remote the location because someone lives downstream of any discharge into the environment, feeling the effects of any release into a waterway.

Field employees must understand the need to protect the environment, their fellow employee, and their company by complying with all regulations. An employee who doesn't know any better can get the maintenance-of-way supervisor in just as much trouble as the unsafe employee or the employee with a bad attitude. By showing his concern for the environment, the maintenance-of-way supervisor can improve his employees' attitude toward the environment.

Storm Water

Federal and state governments are now requiring sampling and permits for the discharge from railroad property of certain storm water. All runoff which can be affected by bulk storage or transfer operations such as routine fueling locations, areas for storage of track materials and painting or repair operations falls into this category whether the storm water leaves by ditch, pipe or another type of conduit. It can be anticipated that treatment facilities will be required for areas where sampling reveals contamination through the permitting and sampling process.

Additionally, storm water from construction areas where greater than five acres of land are disturbed are now required to file for permits 90 days prior to the initiation of the work. This portion of the storm water regulations can also have an impact on the maintenance-of-way supervisor in areas where ditching or clearing operations meet the five acre requirement.

Other problem areas related to clean water include local and state regulations regarding sedimentation and siltation control ordinances and regulations. The development and approval of statewide general plans and permitting is the most effective means for the railroad to deal with these types of regulations.

The operation and maintenance of trackside lubricators can potentially affect surface waters dependent on the lubricator location and type of product used in the lubricator. Installation of absorbent material between the rails on both sides of the lubricator can reduce the deposition of grease in the area of lubricators. When replaced, the absorbent should be disposed in the local landfill unless the material is to be handled as a special waste.

The Clean Air Act

Stationary maintenance-of-way facilities are susceptible to the requirements of the Clean Air Act. Any process which might generate airborne pollutants such as dust, paints, solvents, and stack exhausts should be permitted. Failure to consider the impacts of a new process on the air can result in hefty fines to your company.

There are very few environmental protection regulations which restrict mobile air pollution sources. These types of rules and regulations are normally developed by localities or state governments. As a result, nuisance ordinances are the most likely means of governmental involvement in the maintenance-of-way supervisor's ballast cleaning and other dust generating operations. Efforts should always be made to minimize the generation of dust and other airborne contaminants.

Toxic Substances Control Act

The Toxic Substances Control Act controls the manufacture, processing, use and disposal of certain substances considered to be toxic to the environment and to human health. Of the substances controlled by this act, the two most likely to impact the maintenance-of-way supervisor or his employees are asbestos and polychlorinated biphenyls (PCBs).

Asbestos

Both OSHA and the EPA have developed regulatory programs governing the generation of airborne asbestos. Governmental regulation has made inspection for and removal of asbestos a required step in the renovation or demolition of all structures. Asbestos is often detected in pipe insulation, transite wallboard, floor tile and roofing shingles. Each railroad should develop and adhere to an asbestos safety program in order to protect employees and to comply with state and federal regulations.

Under many state laws any structure to be renovated or demolished must be inspected by a trained, often certified, asbestos inspector. In the event that asbestos-containing materials are identified, the materials must be removed prior to the demolition or renovation activity. The abatement cannot begin until the appropriate agency has been notified in writing and a 20-day notification period has been completed. As you can see, prior planning is necessary even if you want to knock a shed down.

Polychlorinated Biphenyls (PCBS)

The Federal government regulates the use, storage, transport and disposal of electrical equipment which contains PCBs.

The level of regulation regarding electrical equipment is dependent on the concentration of PCBs in the insulating or dielectric fluid. There are three levels of contamination and regulation.

PCB equipment is any equipment which contains fluid with a concentration of greater than 500 parts per million of PCBs. The liquid, the carcass and any materials which come into contact with the liquid have stringent requirements regarding their disposal. This equipment is regulated with regard to its manufacture, use, transportation and handling.

PCB-contaminated equipment is any item whose liquid contains greater than 50 parts per million of PCBs and less than 500 parts per million of PCBs. The liquid and any item which comes into contact with the liquid have virtually the same stringent disposal requirements and less stringent use restrictions. However, note that the carcasses of PCB-contaminated transformers are not regulated.

Non-PCB equipment is any item which contains less than 50 parts per million of PCBs. This equipment and its liquid are not regulated.

The EPA is very serious in their view of the dangers of PCBs in the environment. They consider the release of PCB fluid into the environment as disposal. This means that spills, leaks, spots, and stains are disposal. That disposal is illegal if not handled for cleanup immediately.

Speaking specifically to spills and related forms of disposal and cleanup, rags or other media used to clean up PCBs are considered as non-liquid PCB items and are regulated just as stringently as PCB liquids. Clothing or shoes which come into contact with fluid concentrations greater than 50 ppm PCBs must be disposed of as non-liquid PCB items. Spills of PCB liquids must be stopped as quickly as can safely be done. The spilled material must be contained and prevented from reaching any water or drain. Spills of greater than one gallon of PCB containing liquid must be reported to the EPA regional office within 24 hours. Cleanup of the spilled material and any resultant contamination must be completed within 48 hours regardless of holidays or weekends.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

The main purpose of FIFRA is the registration and safe use of pesticides and herbicides. The regulations were most recently updated in 1980. Under the 1980 regulatory revisions pesticides and herbicides are considered either restricted or general use products.

Restricted use products must be applied under supervision by a certified applicator. Included in the list of restricted use products is creosote. Whenever creosote is applied in the field it should be applied by a certified applicator.

General use products do not require the certified applicator but must be applied by strictly adhering to the instructions on the label of the product container. A little bit more pesticide or herbicide than listed on the label will not do a better job. In fact, it may physically endanger the employee and the environment and can expose the employee and his supervisor to criminal liability.

Resource Conservation and Recovery Act (RCRA)
Solid and Hazardous Waste

As stated previously, the federal government told us in 1976 that we could not pollute the land through the disposal of solid and hazardous waste. The subsequent update of the Resource Conservation and Recovery Act in 1984 tightened the already existing waste disposal regulations. Continuing changes have prohibited the disposal on the land of any liquids.

These regulations and their updates pose the greatest challenge to maintenance-of-way employees of all the statutes. To deal with the application of these regulations a basic understanding of the terms solid, hazardous and non-hazardous waste is absolute necessary.

Federal and state regulations define the term “solid waste” as any discarded material, gaseous, solid or liquid, which is abandoned, burned, disposed, spilled or handled in a manner which constitutes disposal. A material is not a waste until it is designated for disposal. Solid waste can be hazardous or non-hazardous.

A solid waste can be a hazardous waste if: (a) it exhibits certain governmentally defined characteristics; (b) if it is listed as a hazardous waste by name; (c) if it is listed as hazardous waste because of the process from which it comes. Additionally, any time non-hazardous waste is mixed with one of these three types of hazardous waste the entire mixture becomes hazardous no matter how small a portion of hazardous waste is involved.

The wastes which are listed by name or because of their process source are easy to identify. But, the determination of a characteristic waste is a much greater challenge. These wastes must be subjected to a series of laboratory tests to find out whether they are ignitable, corrosive, reactive, or toxic as defined by the government.

The term “ignitable” means that the waste has a flash point of less than 60 degrees centigrade. Most solvents are ignitable; gasoline is ignitable.

Corrosive means that the waste has a pH of less than 2.0 or greater than 12.5. Corrosive is the effect that acid and caustics have on materials with which they come into contact.

Reactive means that the material undergoes violent change or generates toxic gases as a result of the change when it is mixed with other readily available materials such as water or air. Explosives are reactive wastes if discarded. Cyanide is reactive if exposed to low pHs or acidic materials.

A material is determined to be toxic through an exhaustive and expensive series of laboratory tests which simulates the conditions you would find in a landfill over a several year period. The waste sample is tested to see whether it will release certain toxic constituents into the groundwater. The constituents of concern are principally heavy metals (such as lead, mercury and chromium) and solvents and herbicides. The Federal government places limits on the concentrations of these constituents which are permissible for non-hazardous disposal.

To handle your hazardous waste you must determine through laboratory analysis whether the waste is hazardous by characteristic. The cost can range from $500 to $1,800 per sample and the time required for analysis can be as long as six weeks. You accumulate the waste in approved containers and store it on site no longer than 90 days. You arrange for transport using an EPA licensed hazardous waste transporter and dispose the waste in an EPA licensed hazardous waste disposal facility. Along every step of the way the waste is accompanied by a uniform manifest. You maintain impeccable records following governmental guidelines and submit regular reports to the state or federal government documenting all of your hazardous waste activities. That way if something goes wrong at the disposal facility there is no difficulty finding the generator. This is called the EPA's "cradle to grave" control of hazardous waste. The cost of your hazardous waste disposal, not counting lab analysis, should vary from a low $250 per drum to as much as $40,000 per dumpster. The present hazardous waste regulations are designed to ultimately eliminate the generation of all hazardous waste.

Non-hazardous wastes are the wastes that do not fit the definition of hazardous waste. These wastes are not subject to the hazardous waste regulations. Non-hazardous waste includes garbage, refuse, sludges and other benign discarded materials. Non-hazardous waste can typically be disposed in your local landfill. It cannot be buried on your property unless you have a permit to operate a landfill.

In effect, you cannot bury any waste without the benefit of a permit. Obtaining a permit for a simple non-hazardous waste landfill is tremendously involved and, in the long term, quite expensive.

To handle your non-hazardous waste you accumulate waste in dumpsters or other trash receptacles for several days then, either take your waste to the local landfill or have your waste picked up by the municipality or local commercial solid waste/garbage hauler. The costs of disposing of solid waste can vary significantly depending on the location of the landfill, the availability of space in the landfill and local tax structures. Typically, the cost of non-hazardous waste disposal will range from one-tenth to one-hundredth of the cost of hazardous waste disposal.

In some instances, a waste must be handled at a hazardous waste facility even though it is not hazardous. This material may be considered a special waste. This may be due to the inability to find a municipal landfill which will accept the waste in question. Material such as sludge or soil with excessive oil contamination may fall into this category. Another situation in which you treat a waste as a special waste can occur when you must obtain permission from both the municipality and the state to dispose of a waste in the local landfill. This can be a waste that normally is handled as a hazardous waste but does not meet the definition in a particular instance, i.e., paint blast media and products.

Maintenance-of-way employees encounter hazardous and non-hazardous waste disposal problems every day. Let's look at a few of these wastes.

Used Oil

Used oil from vehicles and machinery and waste fuel oil are generally considered non-hazardous. Note that a few isolated states such as Missouri have identified used oil as hazardous. Typically, the used crankcase oil can be disposed through local service stations or placed in wastewater treatment plant waste oil storage tanks unless it possesses a characteristic of hazard waste or has a hazardous waste mixed with it. Additions of waste oil to waste oil storage tanks must be monitored to avoid rendering the whole tank of material a hazardous waste.

This method of disposal does not apply to cutting oils or hydraulic oils or oils mixed with solvents. Cutting oils are often high in metal contamination making them potentially hazardous; hydraulic oils contain contaminants and wreak havoc in wastewater treatment plants and any oil which contains solvents is considered hazardous. The mixture of any of these oils could make all the contents of the waste oil tanks at the wastewater plant hazardous. To dispose of these types of oil you must verify that the material is not hazardous by characteristic.

You should be aware that the federal government is considering the question of whether to identify waste or used oil as a listed hazardous waste.

Oil Filters

The Federal government recently generated new guidelines for the disposal of oil filters. These guidelines state that oil filters can be assumed not to be hazardous waste when disposed if the filters are not constructed of a tin/lead alloy called terne and are drained at engine temperature for at least 12 hours. After draining, the filter should be disabled and the carcass sent to a metal recycler.

In facilities where significant numbers of filters are generated, another alternative to be considered would be to analyze a representative sample of filters to prove the filters non-hazardous. The filters, if proven non-hazardous, could then be disposed through normal disposal means when drained.

In the case of single vehicle oil filters, drained filters can be disposed in dumpsters. This is a legal method of disposal due to the small quantity of waste involved and due to the fact that there is no liquid oil remaining in the filter.

In each case the oil drained from filters should be placed in a waste oil storage tank or in drums in preparation for disposal.

Batteries

Highway vehicle batteries, when replaced, should be returned to the sales location point from which the replacement battery is purchased. If possible, the same handling should be afforded roadway equipment batteries. If this is not an option through the supplier, then the battery will likely be hazardous and should be handled through a battery recycler or hazardous waste disposer. The suggested handling for disposal or recycling can be obtained from the battery supplier.

Lantern batteries can also be hazardous. Most railroads purchase large quantities from one supplier. That supplier can advise as to whether the particular batteries are hazardous when disposed. If lantern batteries are non-hazardous they can be placed in the dumpster. If they are hazardous then they must be handled for disposal just like other hazardous wastes.

Crossties

Under the accepted definition of hazardous waste by characteristic, crossties are not hazardous. Ties are not hazardous by listing on a Federal scale. Individual states maintain the right to define creosoted crossties as hazardous. In general, however, most states consider creosoted crossties as construction or demolition debris. As construction debris the ties must be disposed in construction debris landfills.

Ties being cascaded down to lower level uses can be accumulated neatly along the right-of-way in stacks, not strewn helter skelter. However, when the intended handling of a tie or ties is disposal you cannot discard them along the right-of-way or burn them. Your options should include local landfills. Bear in mind, as in any situation, the landfill operator can refuse to accept your ties. In the event that the local landfill refuses your ties your other options include shipment to a locale where ties are acceptable. Ties must not be buried without a specific permit.

Paint, Paint Solvents and Paint Waste

In a majority of cases, paint, paint solvents and other paint wastes are hazardous due to either ignitability from the solvents or the presence of lead and/or chromium. If the waste is mixed with no other hazardous constituents and its MSDS states that the material does not include hazardous constituents, the waste should be sampled and analyzed to determine whether it is hazardous.

Whether hazardous or non-hazardous there are a number of recycling companies which can provide recycling alternatives. Recycling and disposal of hazardous paint wastes should be handled only through reputable, permitted hazardous waste professionals. Paint, paint solvents and paint waste must never be buried.

Paint Blasting Waste

Waste from sand and grit blasting of paint can be hazardous depending on the metals content of the paint being blasted. As with the paint waste and solvents the material should be sampled and analyzed to determine whether the waste material is hazardous. Due to the length of time involved in analysis, several weeks of lead time are always necessary. In the event that the waste is hazardous then it is handled in the same manner as the paint and solvents discussed previously. In the event that the waste is not hazardous it may still be necessary to handle the waste as a special waste.

Solvents

Other solvents are considered hazardous. This includes parts cleaning solvents and electrical solvents. As stated previously, a number of companies provide recycling alternatives. Prior to recycling or disposal of any waste solvents you should sample and analyze the waste to determine whether the waste material is hazardous.

Welding Waste Products

There are a number of types of welding and cutting operations employed by maintenance-of-way employees. Likewise there are a number of possible waste products generated by the various processes. The waste materials should be tested to determine whether they are hazardous or non-hazardous. No matter what the nature of the waste, it should not be buried or dumped. It should be disposed through the local landfill. As always, proper protective equipment should be provided and properly worn by personnel.

Another aspect of the RCRA laws are those regulations dealing with underground storage tanks. These regulations were necessitated to protect the nation's groundwater. Maintenance-of-way personnel who maintain responsibility for a territory oftentimes have small fuel tanks installed to save them the trouble of going to the gas station down the road. Starting in December, 1989, all owners of underground storage tanks were required to remove, or upgrade at great cost, all of their underground storage tanks over a five year period based upon tank age. In the event that a tank is suspected of leaking, now or in the past, the owners must remediate the contaminated soil and groundwater.

You have, no doubt, noticed the effects of this law in daily life. You see local mom and pop gas stations beginning to disappear from your community as owners find compliance with the new underground storage tank laws harder and harder.

All pressurized piping associated with underground storage tanks must now be tightness tested. Additionally, all tanks installed prior to 1980 must be tightness tested and have leak detection installed. Otherwise, the tank must be removed from the ground. By 1998 all tanks must have cathodic protection installed and maintained by a certified cathodic protection expert. Automatic spill and overfill protection must also be installed by that time. Tanks continuing to operate must institute accurate and expensive recordkeeping measures. As you can see, operation of an underground storage tank is no longer simple or inexpensive.

The cost of regulatory compliant removal of underground storage tanks may vary from $3,000 to $20,000 depending on the size of the tank. If leaks are detected, site assessments can cost an additional $2,000 to $30,000. Remediations can cost up to hundreds of thousands of dollars and take months to years to complete.

The cost of compliance is significant. Non-compliance can be more costly. If you are operating a non-compliant underground storage tank, civil and, in some cases, criminal liability can result.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA - Superfund)

The Superfund laws govern the cleanup of old contaminated sites. Past activities conducted by industries, even railroads, could have caused a site to be contaminated. Old disposal areas for maintenance-of-way waste could be included under this description. The definition and cleanup of these sites should be dealt with by qualified, reputable professionals.

Other Environmental Concerns

In addition to maintenance-of-way compliance in the normal environmental programs, there are a number of problem areas where protection of the environment must be addressed. The following situations must be dealt with in an environmentally sensitive manner.

Poor housekeeping in areas of material storage, especially areas of tie storage, can result in the claims of illegal disposal of those materials by local governmental agencies or special interest groups. Bad housekeeping can have a significant impact on the environment if it occurs in the local floodplain.

Fueling and maintenance of equipment must be handled efficiently while minimizing the effects on the environment. Gross spillage of fuel and intentional dumping of equipment lube oil must not be tolerated. This type of practice must be avoided even at the lowest level.

Derailment cleanup efforts must be handled with the environment in mind. The gross burial of rail equipment or lading damaged in derailments would constitute burial of waste and would, therefore, be illegal.

Drainage-generated environmental problems can arise through the failure to comply with state and local sedimentation laws. When reinstating flow in clogged culverts or pipes, consideration should be given to the effects of heavy stagnant flow on neighbors and the environment.

Even ballast operations can generate problems to the environment. If hazardous materials or toxic substances have been spilled onto ballast removed in yard cleaning operations, it may be hazardous no matter where you place it. This does not mean that you must check every truckload of ballast but it does mean that you should be wary of the potential for significant contamination of the ballast.

At What Cost?

By now most of you are thinking how badly your budget is going to be affected, but compliance with the maze of environmental regulations is positively necessary. Compliance can be done through waste minimization. Don't throw away solvents after one use. Paint solvents used to clean equipment can be used as a paint thinner later. Inventory control can eliminate waste of paints, herbicides and other consumable items. Waste materials can be recycled. Waste materials can, in some instances, be used as fuel for energy recovery.

The alternative is not less costly. Ultimately, you still pay the tab and run the risk of paying a fine or doing time.

Considering only those laws in effect now, the future will lead us to increased scrutiny of sandblasting and painting operations. The disposal of our hazardous and non-hazardous waste will become increasingly more difficult and expensive.

Each railroad will find that tightening regulations and rapidly decreasing landfill space will result in much more costly disposal of all solid waste, even common garbage, in the future. The government is not standing still. Other regulations being considered now in state and federal agencies will place further requirements on those owning above ground storage tanks.

Regulators will tighten the noose of criminal liability for those who ignore the need to protect the environment. Don't try to skirt the regulations; the consequences are not worth the time and money saved if you are paying criminal fines or marking time in jail. They are now looking for the highest official possible to prosecute in worker and environmental impairment cases.

Protection of the Employee

With the heightening of interest in the environment we also recognize the need to protect the general public from chemicals and, specifically, the working man from harm in his workplace. In the eighties great strides were made in protection of the working man from the products of his man-made environment.

OSHA Hazard Communication Standard

Just about everyone uses chemicals of one form or another as part of daily living and in the workplace. To protect employees in the use of workplace chemicals, the OSHA Hazard Communication Standard went into effect for certain industries, primarily those involved with the generation of chemicals, as early as 1985. The standard became effective for the railroad industry in 1988.

Industry must insure that the maintenance-of-way employee has the equipment, general knowledge and training to deal with the inherent dangers of the chemicals and products of the modern day man-made environment.

Today's railroader must be protected by, at a minimum, an employee right-to-know program. The employee right-to-know program should be supplemented with a hearing conservation program and a respiratory protection program in order to advance employee knowledge and personal protection from noise and exposures to fumes.

Prior to discussing the particulars of the OSHA regulations one should always remember that virtually any materials out of place or in excessive quantity can be hazardous. This applies to paint sprayed near an open flame or water twenty feet deep.

OSHA requires that all employees who must use, handle or work in the vicinity of hazardous chemicals on their jobs must be provided by their employer with a right-to-know program which includes the following features:

- The preparation and maintenance of an inventory of all hazardous chemicals used in the workplace.
- The availability to employees upon demand of information regarding any chemical present in the workplace.
- Employee training in connection with health hazards associated with chemicals in the workplace and potential problems which might arise when working with chemicals.
- Instructions regarding the detection of hazardous chemical releases.
- Provision of protective equipment and clothing to personnel who must use or handle hazardous chemicals.
- The proper labeling of hazardous chemicals.

A well constructed right-to-know program that is adhered to can provide for the well-being of all employees in the workplace.

Hearing Conservation Program

Federal regulations require employers to protect the hearing of their personnel. The employees' hearing must be protected in any workplace where information indicates that noise exposures may exceed an eight-hours time weighted average of 85 decibels on the a scale. The hearing conservation program should be designed to achieve this objective by:

- Utilizing noise monitoring as necessary to detect noise levels at any workplace and repeat monitoring when noise levels change.
- By providing audiometric testing to monitor the audio abilities of employees.
- By providing hearing protective devices to all employees needing such protection.
- By monitoring the compliance of the employee to insure that he complies with the program.

Respiratory Protection Program

In the respiratory protection area OSHA has issued regulations which are intended to provide for the prevention of work exposures to occupational dust, fumes, mists, sprays, gasses and vapors. A well-designed respiratory program will include:

- Elimination of exposures through the use of engineering controls, wherever feasible.
- Provision of respiratory protection whenever engineering controls are not feasible.
- In the areas where engineering controls are not feasible, employees must be instructed in procedures for selecting, fitting, using and cleaning respirators.
- Those employees who have to use respiratory protection must be medically qualified by the employer.

The interest and participation of both the worker and the employer are the supporting pillars for the worker protection programs.

- The worker should never take chances.
- The worker and the employer should never ignore problems.
- The employer should never fail to respond to employee concerns.

Preventive measures taken to insure that day-to-day employee activities and operations comply with worker protection program requirements is the best way to avoid dangers and stay out of trouble.

Conclusion

In summary, today's railroad maintenance-of-way employee must do his or her part to protect the modern day natural environment from air, soil, groundwater and surface water pollution and avoid the incorrect handling and disposal of hazardous and toxic wastes. He must work intelligently, aware of the potential dangers presented by the materials present in the workplace.

Industry must insure that the maintenance-of-way employee has the equipment, general knowledge and training which produce a stable and controlled framework in which it is safe to work and where environmental problems are avoided. Thank you. (Applause)

Mr. Cantrell: Thank you, Mike, for that informative presentation. As a token of the Roadmasters' appreciation I would like to present you with this certificate. Copies of Mike's report are in the back of the room. I encourage each and everyone of you to take a copy because they are informative. I'll now turn the podium over to President Hill.

President Hill: Thank you, Darrell. We've had an informative morning. First, we have to learn a new language so we can talk to the marketing and sales people and whatever money we get from them we have to spend on environmental. That's the way things are going in our industry so it really behooves us to learn these lessons. As Darrell said, there are copies of the presentations in the back. There's also the signup sheets for the subjects for next year and the conference review sheets. Those are very important to us so we can make sure we're delivering what you need to know.

We'll take a short recess now. Roadmasters will reconvene back here and the B&B will meet down the hall in the Cotillion Room.

Recess

TUESDAY MORNING SESSION

September 22, 1992

President Walbrun: The second session of our 97th conference is now in session. The attendance at this point is 695, which is very good this year. I'd like to remind all of you to please take a look at and fill out the yellow cards for our subjects for next year. If you have any information, if you have any experience, if you have any knowledge of the items that are listed in those reports, your input is solicited and will be appreciated. It just takes a few seconds. The cards can be dropped off at the registration desk or mailed back to the headquarters of the B&B Association in Homewood, Illinois.

At this time, I'd like to turn the program over to Don Steele, who will introduce our next special subject.

Mr. Steele: Thank you, Mark. I'd like to introduce Lee Hostler, chairman of special subject No. 3, Falsework for Bridge Construction and Maintenance. Lee is a structures engineer for the Santa Fe Railway. He received a B.S. degree in civil engineering at Texas Tech University in Lubbock. Lee has held the positions of general supervisor of structures, assistant general B&B foreman and steel bridge inspector with Santa Fe. So I'm sure he's going to know what he's talking about on setting up this Falsework.

Special Subject No. 3

Falsework For Bridge Construction and Maintenance

Chairman:	J. L. Hostler, Str.Engr., AT&SF, Albuquerque NM
Committee:	J. Fraise, Gen.Supv.,Strs., AT&SF, Euless TX D. Lozano, Str.Engr., AT&SF, San Bernardino CA J. Quesada, Stl.Br.Insp., AT&SF, San Bernardino CA M. L. Bradley, Proj.Engr., Conrail, Dublin OH S. J. Chapin, Br.Dsgn.Engr., Hays Seay Mattern & Mattern, Roanoke VA J. Glavin, Proj.Engr.Strs., NJTRO, Edison NJ C. Rood, Sr.Proj.Mgr., SEPTA, Philadelphia PA J. J. Horney, Sr.Dir.Cnstr., Amtrak, Philadelphia PA

Thank you, Don. I guess everybody can hear me all right. A doctor, a lawyer, and an engineer were all sentenced to die by guillotine. The doctor was called up there first and the executioner says, face up or face down?" The doctor said, "face up". So the doctor is looking up and the executioner cuts the rope and as the blade comes down, it stops about halfway. The executioner said, "It's a miracle. It's an act of God, you're a free man, go home."

The lawyer is called next. "Face up, face down?" He says, I'll go face up. Same thing happens. The blade stops about halfway down. "It's a miracle. It's an act of God. Go home, you're a free man."

Next the engineer is called and he goes up there and leans back. The executioner asks, "Face up?" As the rope is ready to be cupt, the engineer says, "Now, wait a minute. I think I see the problem." (Laughter)

Introduction

The purpose of this paper is to give a general overview and general guidelines for the use of falsework in various maintenance and construction activities with an emphasis on bridge maintenance and construction.

Falsework can be defined as a temporary means of supporting a load until a permanent structure or repair can be made making the temporary support unnecessary.

History

Shortly after mankind evolved beyond using fallen trees, natural (erosion formed) arches and suspended vines as bridges, falsework became necessary for bridge building. While many structures can be built without it, using falsework is often a more effective construction method. Arches, unless cantilevered, require temporary support until the keystone is placed.

Railroads have made good use of falsework over the years. In building a tunnel between Colorado and New Mexico in 1908, a falsework timber header was placed to support the tunnel soffit until the permanent concrete soffit was installed.

In building a deck truss across the Colorado River between Arizona and California in the 1940s, a temporary bridge far below final grade was built. Caissons and pressure bells were used to be able to cast the piers, followed by erection of the deck truss with lower chord points being supported by the temporary piers.

Maintenance

Falsework is used extensively in maintenance activities and procedures. A frame bent can be jacked from a mud sill to support the timber stringers in a bridge when changing a cap. When working over water or on a high bridge, knee braces can be chained to existing piling and an extra cap can be jacked from the braces to support the stringers. During the time the old cap is out and before the new one is in, no trains should be permitted over the bridge.

On longer steel or concrete bridges, towers can be built to support the beams, girders or truss to do maintenance work on the bearings, bridge seats, caps, piers or abutments. These towers are usually engineered to withstand a train load at a reduced speed due to the length of time usually required to accomplish the maintenance work involved.

On a bridge with a weak timber panel over a dry wash, a frame bent can be placed at mid span to help the bridge carry the live loads until helper stringers can be placed or the deck renewed. On a timber bridge with poor piling, helper (frame) bents can be placed next to the existing bents until the bridge can be renewed. Since helper bents tend to be in place for months and maybe years before repairs to the bridge can be made, they are susceptible to washouts and mud sill driving and must be checked on periodically to ensure their integrity.

Rebuilding the top of a pier cap is accomplished by constructing falsework support towers on each side of the pier. Girders are stiffened with high strength bolted stiffener angles centered over the falsework towers to prevent web crippling. The towers rest on concrete footings cast adjacent to the pier and a short falsework beam span above the pier is supported by frame bents. The girders are briefly jacked to removed existing bearings and place temporary bearing plates centered over each tower. The pier cap is then removed down to good concrete and the new cap is cast.

The same basic procedure is used for replacement of the abutment bridge seat and backwall or parapet. Pile bents are driven in back of the abutment and frame bents are placed in front with falsework beams spanning between the bent and tower.

Construction

When renewing a railroad bridge, often the most economical procedure involves working under traffic. In many cases, a timber deck pile trestle is being renewed with a precast prestressed pretensioned bridge on steel piling. In the case of an existing ballasted deck bridge, the bridge must be opened up in some manner in order to drive piling.

This is usually accomplished by spreading a couple of ties, potholeing the bridge and driving the pile through the pothole. When a bridge with a relatively weak deck and a manageable center height has been potholed, 10 inch x 10 inch helper posts may be used to support the ends of the stringers cut to make the pothole.

In a ballast deck bridge with a very weak deck or a relatively weak deck in a high bridge, the safest way to proceed is to make the bridge open deck and place an extra cap on top of the existing cap to maintain the rail profile.

New construction often calls for cast in place piling, sometimes inaccurately called caissons. This is an augured hole typically two to four feet in diameter which has a cage of reinforcing bars embedded in cast in place concrete. When a piling is to go in a sandy location with a pile tip elevation below the water table, where there is a good chance of sloughage of the soil and the ground water into freshly deposited concrete, the tube of slightly less diameter than the augured hole is inserted to the bottom of the augured hole before the concrete is deposited. As the concrete is placed in the hole, the tube is raised allowing the concrete to fill the contours of the augured hole, but protecting the concrete from ground water and soil intrusion.

Concrete footings, piers and caps which are cast-in-place use falsework commonly know as forms. Forms are fabricated in the field from plywood and two by timber (or larger) or fabricated in the factory from steel. Tubular forms can be made of cardboard. Wood forms can be used only a few times before being discarded; steel forms can be used hundreds of times without wearing out; cardboard forms are used only once and then must be peeled off the member just cast. As you would expect, the cost of the form is of direct proportion to its durability. Plywood forms are reinforced with strongbacks and wales. Strongbacks are made of two bys running vertically and attached by nailing through the plywood and into the strongback. Wales are made of doubled two-by material running horizontally, attached to the forms by toenailing to the strongbacks and they have a spacer between the timbers to allow member ties a place to seat.

Footings are sometimes cast into a rock foundation excavated to the proper elevation and dimensions. These usually are cast without forms. Where forms are necessary, they are attached to one another by toenailing of wooden forms or some connecting device for steel forms, properly reinforced as mentioned above. Then kicker timbers are braced between the form and a deadman outside the form. Many times at a corner, the top of the forms will have two-by timber cutting across the corner and reinforcing the position of the forms.

Piers are designed in a variety of shapes; the shape of the pier will have a lot to do with the choice of forming material for the job. A pier made of one or several round columns, not too great in height, may best be formed by cardboard tubes. Great care must be taken that the cardboard burst strength is greater than the hydrostatic pressure which will be exerted by the concrete and that the tubes are handled with care so that the finished column will not be flawed by the formwork.

Flat surfaces on a pier are easily formed using plywood or steel forms. Plywood forms are tied together through the thin dimension of the pier with snap ties and/or taper ties also known as she bolts. Steel forms are tied together with strap ties. The snap ties and taper ties go through the forms and past the strongbacks and wales a short length. This length is used to anchor the tie to the wale by means of clips known as hairpins or oversized nuts and washers. The ties tensile strength is used to keep the forms in place during the concrete placement and assure an accurate dimension through this section of pier. The use of snap ties or taper ties will vary with design. The strength of a snap tie is approximately 5,000 pounds; a taper tie's tensile strength is 50,000 pounds.

Short radius curves at the ends of the piers, called bullnoses, designed to increase the hydraulic efficiency of the pier are usually formed with a factory fabricated steel form. They can also be formed by bending a double layer of quarter-inch plywood to the appropriate shape, or as in the past, nailing beveled pieces of stock size timber together until the semicircle has been formed.

Piers with a narrow stem at the bottom, flaring out to the bridge seat, require a great deal of forming and bracing to support the top of the pier during construction. Bridge designers should be careful to make sure the dollars saved in steel and concrete in the pier is greater than the dollars spent forming their exotic design.

Pier forms are generally guy-wired off at the top and sometimes at mid height on taller bridges to ensure that the forms stay plumb and in line while the pier is cast.

Bridge superstructures make for the most creative uses of falsework. Beyond the formwork challenges of cast-in-place concrete beams or girders lies the challenge of supporting them during concrete placement. Today's cast-in-place beams are almost always prestressed, post tensioned. That is, the concrete is cast before the strand cables are stressed, which is before designed live loads are applied. The prestressed, post tensioned beam must be cast flat or with a slight camber. The most cost efficient way in which to cast these would be on natural ground excavated to just below the bottom of the beam and formed up from there. However, many times this is not an option and the bridge builder must falsework up from finished grade under the bridge. In either case, the falsework designer must take into account the deflection of the ground under the load of freshly placed concrete. In the instance where falsework must be built from any distance below the bottom of beam elevation, the axial deformation of the falsework columns and the falsework girder deflection must be accounted for to have a finished beam at the desired profile. The falsework designs, common place in new construction, can become very complicated and are the most likely place for catastrophic failure.

During new construction, prestressed pretensioned concrete beams, like steel beams used in railroad work, usually come from the fabricator ready to set on their bearings and require no falsework.

As noted earlier when renewing an existing railroad bridge, the most cost effective method is to renew under traffic. After the substructure of the new bridge has been built, a method must be devised to quickly remove the old superstructure and place the new one. Most of the time, a falsework substructure is built on either one or both sides of the existing structure. On one side, the new superstructure is completely assembled. On the day the track is taken out of service for the renewal, the old superstructure is removed and set either on the falsework substructure or on the side opposite the new superstructure or placed on the ground and the new superstructure is rolled or slid into place.

Sometimes, construction of the new superstructure cannot be accomplished on the falsework substructure, but rather on the ground a short distance away from its permanent location. In this instance, falsework must be built up to the adjacent falsework substructure. The new superstructure must travel along the approach and onto the falsework substructure before being moved to its final destination. If the new superstructure is being rolled, it must be jacked at the falsework substructure and rollers turned before the final set takes place.

Falsework Failures

Research has unveiled no published accounts of falsework failures and their causes on freight railroads in the recent past and only one on a light rail line under construction in Long Beach, California. All other reports have been found to be under highway bridge construction, so that is where this paper will concentrate.

There have, in fact, been few articles on falsework failures and most of them have been in "Engineering News Record." These failures include the Sunshine Skyway in Tampa Bay, the Dan Ryan Expressway in Chicago, the Mississippi River Arch in St. Paul, Minnesota, a bridge in San Diego, Los Angeles County Transportation Commission in Long Beach and the Century Freeway in Los Angeles.

The cause of the Sunshine Skyway collapse has not been published. The Dan Ryan Freeway falsework failure was caused by shoring collapse. An error in design was the cause of the Mississippi River Arch falsework failure, in which a man died. In that instance, a concrete arch was being cast over the Mississippi River. The falsework being used was a truss structured so that barge and other river traffic would not be impeded by the new construction. The weight of the newly poured concrete arch for the new bridge crushed a falsework support beam underneath the truss. The estimated applied loads at the time of the collapse exceeded the allowable web crippling for both "as designed" and "as built" conditions of the support beams. Due to the complexity of the entire supporting system, it was difficult to calculate the revised load paths and thus figure the sequence of final collapse.

The San Diego bridge falsework collapse was caused when a crane dropped its load onto the falsework.

An estimated $1 million in damages was caused by the collapse of the Los Angeles County bridge falsework. The investigators were looking most closely at the temporary timbers as well as concrete footing under the falsework and soil conditions at the site. This failure occurred in only one span of the bridge; the rest of the spans were not affected.

The Century Freeway falsework collapse occurred after the permanent bridge had been cast and the falsework was being dismantled. The cause of the failure was determined by Caltrans to be (this author's favorite) "a statistically improbable combination of circumstances." The permanent structure had acquired enough strength and continued to stand. The cost of the failure was not excessive.

Other falsework failures, which occur with some frequency but usually do not result in catastrophes, are soil failures, where the earth under a mud sill compresses or shears resulting in either resetting or shimming up the falsework bent or tower; and the removal of concrete formwork prematurely which would cause the concrete to slump away from its desired location, which would require the failed concrete to be removed and recast.

Temporary Retaining Walls

Often, temporary retaining walls and/or trench shoring must be built where a track or roadway must be kept in service adjacent to construction activity and insufficient space is available to allow the insitu soil to obtain its natural angle of repose from the top of the excavation to the bottom.

The most common types of temporary retaining walls are cantilevered H-beam soldier piles with timber lagging, cantilevered sheet piles, tied back H-beam soldier piles with timber lagging and tied back sheet piles. Each design must take into account the active and passive soil pressure, the density of the soil, the cohesiveness of the soil and the height of the water table. Tied back retaining walls require less pile depth and have less deflection at the top of the wall than their cantilevered counterparts, but are usually more expensive. The piling can be driven into place or placed in an augured hole. When placed in an augured hole, the piling can be backfilled with a sand-cement slurry. Typically this backfill material will contain about one sack of cement per cubic yard of slurry.

Summary and Conclusions

As we have seen, falsework is a diverse and sometimes complicated subject to study. Simple applications are used most often in basic maintenance operations, whereas complex falsework structures are used more often for bridge renewals and new construction. Failures occur in many ways. Regardless of the mode of failure, money is wasted and injuries and death sometimes occur.

Simple falsework design is usually based on prior usage in a similar situation where the foreman and the B&B gang will use a method that has been tried with success in the past. This method is not always the most efficient in terms of volume of materials used, but is usually the best because of material availability, design time constraints and worker familiarity. It generally has a safety factor greater than would be called for in codes and at some time in its past, the falsework bent or other simple falsework device has been designed by a graduate engineer.

The more complicated and unusual the job gets, the more engineering is required for the design and inspection for the installation of falsework.

Regardless of its complexity, successful usage of falsework is essential, to the quality, economy and safety of the maintenance and construction of the American railways' bridges and buildings. Thank you. (Applause)

Mr. Steele: Thank you, Lee. That was an excellent presentation. I know the effort you had to go through to put it together, because a lot of us have done it. It's a lot of work and we appreciate it.

Our next special feature is a topic different from what was planned thirty days ago. I owe a lot of gratitude to Bill Dowd for being able to give us a presentation on such short notice. Bill will be addressing us on the feasibility study for the Union Pacific Railroad Blue Mountain Tunnel at LaGrande, Oregon.

Bill is the senior vice president and national technical director of bridges for HDR Engineering in Omaha, Nebraska. His responsibilities include coordination and inter-office design activities among 14 bridge design centers. He has managed numerous railroad bridges and tunnel projects throughout the western United States.

Bill received his B.S. and masters degrees at the University of Nebraska. His professional activities include, AREA; American Society of Civil Engineers and past president of the Nebraska Section; American Concrete Institute; Pre-Stressed Concrete Institute; National Society of Professional Engineers; and Nebraska Society of Professional Engineers.

He has written four technical papers and presented these throughout the United States and Scotland. These papers are the Design of Deep Footings for Ship Impact Loading, Design Innovations for Steel Plate Girder Bridges, Proposed Procedures for the Design of Low Friction, Spherical Bridge Bearings and The Design of the Construction of the First Concrete Segmental Bridge spanning the Missouri River. I'd like to present Bill Dowd.

UNION PACIFIC'S PROPOSED BLUE MOUNTAIN TUNNEL

Bill Dowd

Senior Vice President
and National Technical Director
HDR Engineering

The Union Pacific Railroad is investigating the feasibility of constructing a 10.6 mile tunnel through the Blue Mountains of northeastern Oregon. The tunnel, which has the potential to be the longest railroad tunnel in North America, would bypass a rugged, steep section of railroad which has been both expensive to operate and to maintain.

The consultant team led by HDR Engineering, AGRA Industries, Lachel & Associates, and British Rail Research considered five separate tunnel alignments with various grades and tunnel lengths. Each would be constructed through similar geology. The feasibility study concentrated on geological conditions, construction methods, cost, mechanical systems, and needs of the Union Pacific.

The tunnel study team was authorized by the Union Pacific to study the technical feasibility of the construction of a single track, bi-directional tunnel through the Blue Mountains of Oregon. The proposed tunnel would eliminate steep grades and sharp curves on the Union Pacific main line between LaGrande and Pendleton. The results of the feasibility study indicate that the tunnel could be constructed and operated using existing design and construction practices, and adequate ventilation for train operation can be achieved. The completed facility would greatly improve railroad operations by increasing service reliability and reducing transit times.

Background

Union Pacific's current alignment through the Blue Mountains was laid out in the 1870s. Union Pacific has continued to operate over this route, making only minor improvements in track geometry. The route is a rugged, steep section that is expensive both to operate and maintain. Current ruling grades between LaGrande and Pendleton are 2.2 percent westbound and 2.0 percent eastbound.

In the early 1970s, UP's engineering staff considered tunneling to eliminate the Blue Mountain grade and thereby reduce fuel consumption during the oil embargo. However, the fuel crisis ended before tunnel plans could be implemented. In 1978, UP's Office of Strategic Planning, prompted by disruptions in traffic flow caused by winter storms, included the tunnel in its long-range planning. The topic was revisited when the UP engineering staff performed a study which evaluated the benefits the proposed tunnel could provide for the railroad.

With growing traffic levels, and following the recent successful completion of CP Rail's Mount Macdonald Tunnel, Union Pacific commissioned the present study to assess the following issues for one of several tunnel alignments:

- surface and subsurface geology
- hydrogeology
- tunnel design and methods of construction
- tunnel ventilation
- tunnel/rail operations interface

Tunnel Alignment

The consultant team considered five separate single-track tunnel alignments with various grades and tunnel lengths. Each would be constructed through similar geology. The options with flatter grades accommodate faster train speeds and minimize ventilation requirements. The shorter options provided the most acceptable distance between sections of double track mainline. After consultation with Union Pacific engineering department personnel, the study effort was concentrated on the K-2 tunnel alignment. This option would be constructed on a +0.36 percent grade (ascending eastbound) and would have a length of approximately 10.6 miles.

Track Geometry

With turnouts located approximately one quarter of a mile outside the portals, the resulting section of single track mainline through the tunnel would be 11.1 miles and would tie into the present mainline at Camp on the west and Perry on the east. Improved double track mainline is recommended at both ends of the single track section.

To maximize operating train speeds on the single track segment, it is recommended that the west approach grade be adjusted to provide a maximum grade of +1.0 percent for two miles west of the west portal. A grade of +1.37 percent for three miles would be required to tie back into the existing mainline approximately five miles west of the proposed west portal. It is proposed that the curves required to tie into the existing mainline at each end be limited to three degrees in order to maintain a track design speed of 50 miles per hour between the double main track sections. Additionally, numerous curve reductions and grade reductions are proposed in conjunction with the tunnel construction to improve rail operations throughout the territory.

Geology

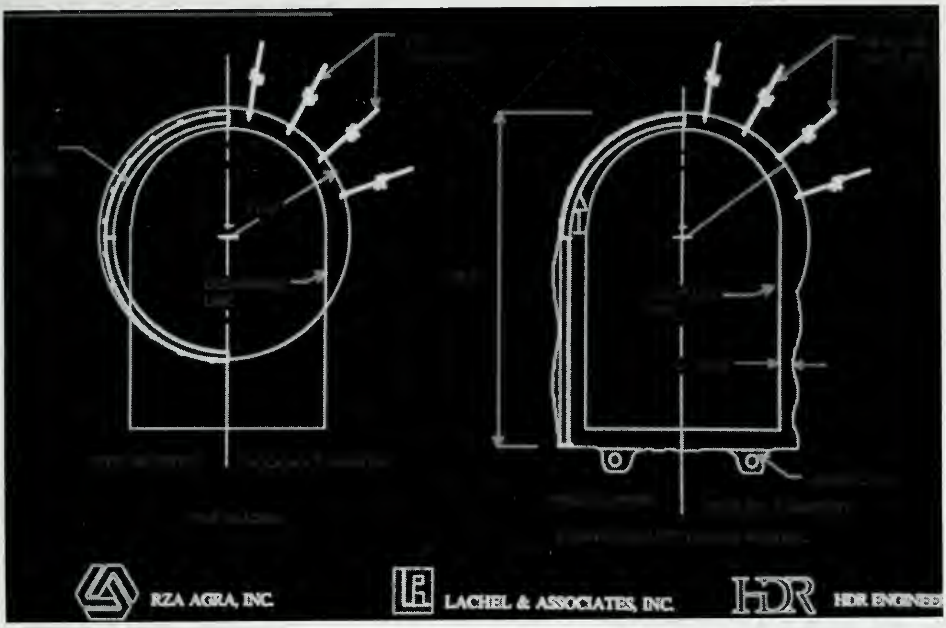
The geology through which the tunnel would be driven consists of multiple flows of the Grande Ronde member of the Columbia River Basalt Group. These flood basalts originated from a series of fissures located about 30 miles northeast of the tunnel project area. Typical of flows near their source, individual flows are relatively thin, ranging in thickness from 30 to 100 feet. The primary flows are laterally continuous and are nearly flat-lying. Each flow is separated by an interflow zone or interbed which is composed of consolidated to unconsolidated ash, clay and weathered basalt and blocky rubble. Following deposition, this sequence of flows was uplifted to form the Blue Mountain anticline and was subsequently cut by fault action.

Several interbeds will also intersect with the tunnel alignment. The interbeds, which vary in thickness, are less competent material and will require more substantial ground support. No active faults are present near the tunnel site. However, the alignment is expected to cross inactive fault zones at three or four locations. These fault zones are expected to be approximately 15 to 45 feet wide. The sheared and faulted rock at the fault zones will require the most substantial ground support. The tunnel alignment is below the regional water table. The hydraulic head ranges between 200 to 650 feet above the tunnel's elevation. Expected groundwater inflow is estimated at 500 gallons per minute (30 liter per second) after construction. It will be necessary to handle larger volumes during construction. Overall, the geology is considered favorable for tunnel construction.

Tunneling Options

Three methods of tunnel excavation are considered technically feasible at the site:

- Full-face excavation utilizing the drill and shoot method of excavation.
- Keyhole method using a 22 feet diameter tunnel boring machine (TBM) for the upper heading followed by invert excavation using the drill and shoot method.
- Full-face, single-pass excavation using a 30 feet diameter TBM.



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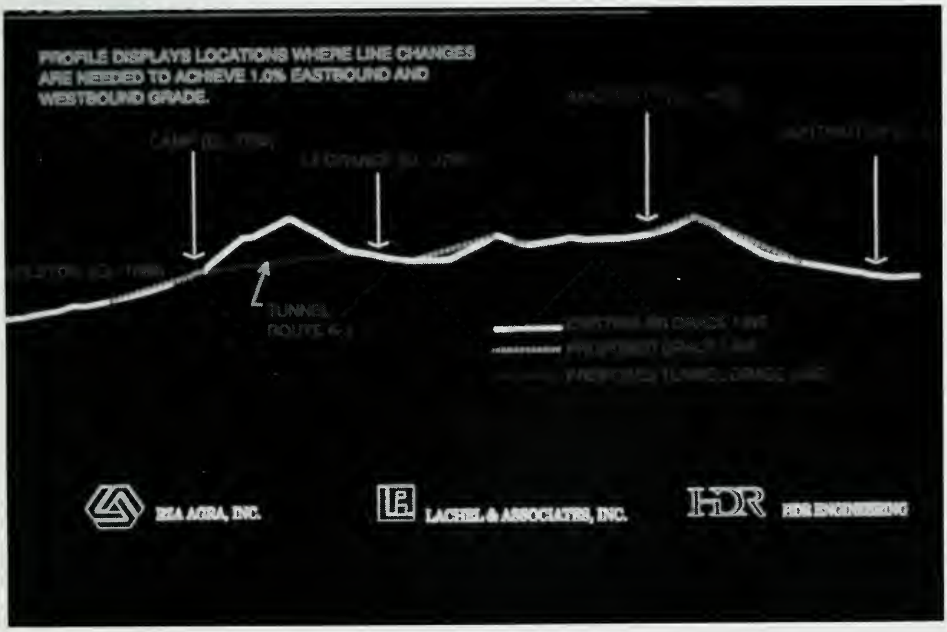


PROFILE DISPLAYS LOCATIONS WHERE LINE CHANGES ARE NEEDED TO ACHIEVE 1.0% EASTBOUND AND WESTBOUND GRADE.

RZA AGRA, INC. **LACHEL & ASSOCIATES, INC.** **HDR ENGINEERING**

After installation of the concrete liner and track, the first two methods would result in a tunnel interior matching the clearances established by Union Pacific to meet current and projected requirements. These controlling dimensions are 17 feet wide by 25 feet high above top of rail. The third method would result in additional annular space on both sides of the required railroad clearance envelope.

Temporary rock support will be required for all tunneling methods. Because of the varying competence of the rock material due to faulting and the presence of the interbeds, support is estimated to range from a pattern of rock bolts in the crown of the excavation, to crown rock bolts with a temporary shotcrete liner, to the use of structural steel sets and timber lagging in the least competent and heavily faulted materials. Primarily because of ventilation requirements, a smooth-finished, cast-in-place concrete permanent liner will be necessary with each of the tunneling methods.

Because the keyhole method yields the appropriate cross section for the tunnel and is anticipated to result in the least amount of overbreak, it has been used as the basis of the detailed estimates. Each of the tunneling methods will be evaluated in greater depth during the preliminary and final design stages, with alternate designs being considered for the final bid documents.

Mechanical ventilation fans and tunnel gates are required for three operational reasons:

- To provide airflow past operating trains to cool locomotives in the confined space of the tunnel.
- To purge the tunnel of air polluted with the products of combustion from the locomotives.
- For life safety provisions during fires, chemical spills, or other emergency conditions.

Locomotive Cooling

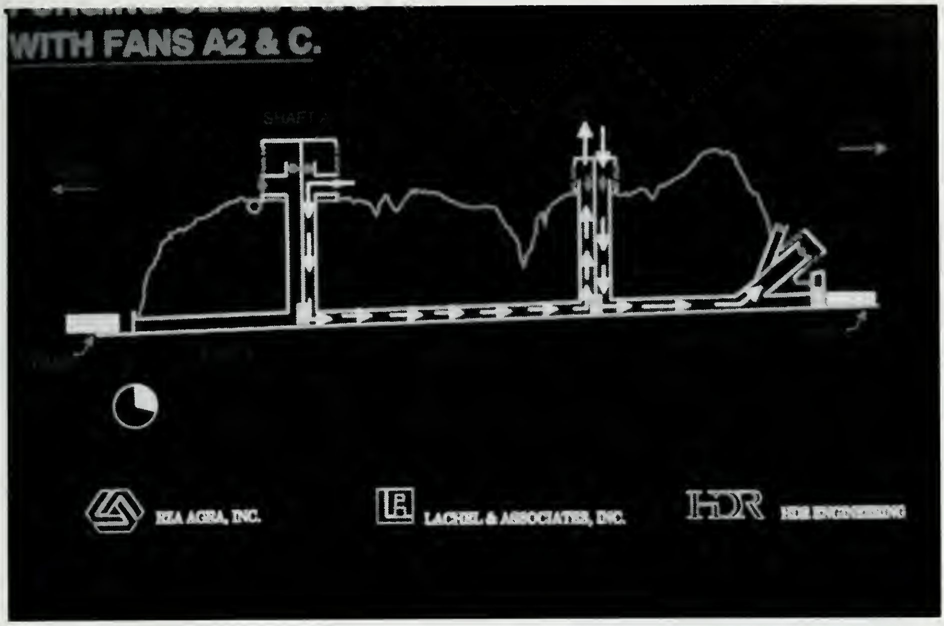
Trains operating through unobstructed tunnels will force a large percentage of the air in the tunnel to move with the moving train. This is referred to as the piston effect. For proper operation of the diesel-electric locomotives, the air temperature at the intake of the locomotive's cooling system must be controlled to allow the cooling system to function properly. If the piston effect is uncontrolled, the air temperature at the intake of a locomotive unit will be unduly influenced by the high temperatures created by locomotive units preceding it in the power consist.

Cooling can be accomplished in two methods:

- Restricting the free flow of air ahead of the train by using tunnel gates and control dampers, thus forcing air past the locomotives (gate and damper cooling).
- Inducing airflow by using high pressure fans in combination with tunnel gates (supplemental cooling).

For nearly all normal operation conditions, the first method of cooling is anticipated to be adequate. For heavy trains ascending the +0.36 percent eastbound grade, the second method of cooling may be required for a short duration under extreme high temperature summertime conditions.

Because westbound trains will be operating on a downgrade, neither of the above methods of cooling will be required except upon entry into the tunnel. Entrance cooling may be necessary due to the existence of the -0.70 percent approach grade east of the east portal. Until an adequate percentage of the train mass breaks the crest of the vertical curve, the first method of cooling may be necessary. Full scale testing using existing tunnel facilities is recommended to optimize the cooling system design. Through such testing, it will be possible to avoid an unnecessarily conservative design so as to minimize capital investment and operational costs.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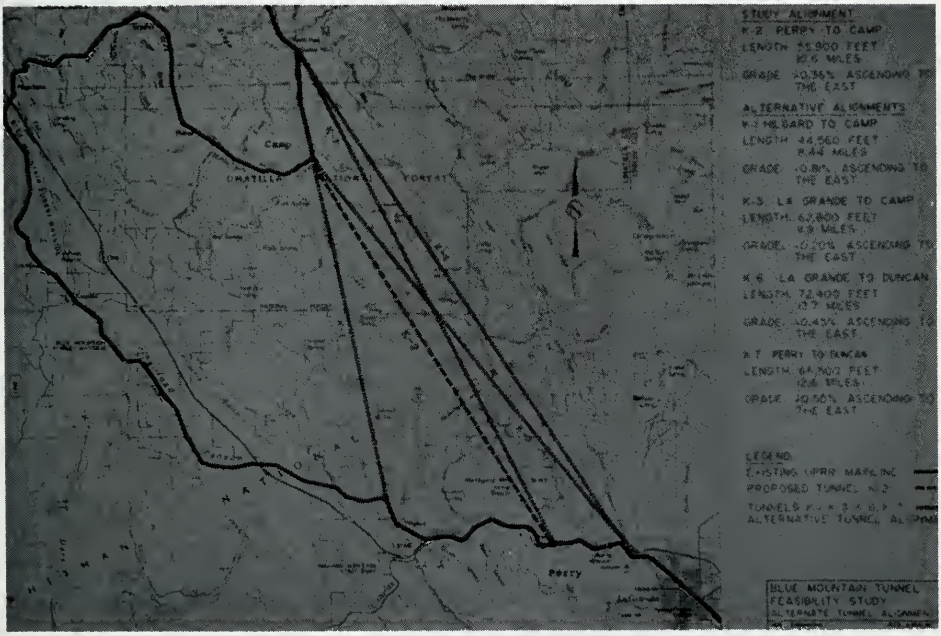


Purging

For life safety reasons it is necessary to remove the polluted air from the tunnel after the passage of a train. Approximately 1.25 times the air volume in the tunnel must be changed out. The unrestricted portion of the airflow from the piston effect will accomplish some of this air change. However, large mechanical ventilation fans will be required for the major portion of the purging duty.

The ventilation cycle has been designed to purge in the direction of train movement in an attempt to minimize fan power requirements. To reduce the time necessary to purge the entire tunnel in order to minimize the headway between trains, it is proposed to divide the tunnel into three separate cells separated by tunnel gates. Air passages are provided at both ends of each cell utilizing the portals and vertical shafts in the interior of the mountain. Mechanical fans are situated at strategic points to ventilate each of the three cells independently. Fans have been sized to produce airflows in the tunnel of up to 28 miles per hour to minimize the purging time. Reversible fans are proposed to give the option of purging in the direction of train movement in order to maximize the benefits of the piston effect. Reversible fans are also more flexible in providing for emergency operations. Because the trains ascending the grade will produce more products of combustion and will be in operation against a more constricted air passage for cooling purposes, the purging time per cell for eastbound trains will be significantly greater than that for westbound movements. For example, if an eastbound train follows an eastbound 8,000 feet train with four 3,600 horsepower locomotive units and 8,000 two trains operation westbound, the time between the two head ends would be approximately 9 minutes, or a time consistent with normal train operation procedures.

Operational Control System

A sophisticated control system will be necessary to operate the mechanical equipment in an efficient manner while maximizing the efficiency of train operations. Temperature, pressure, and haze detection instrumentation will be needed in addition to track signal circuitry as input to the control system. State-of-the-art continuous monitoring of locomotives linked with the control system may also be beneficial in maximizing the efficiency of tunnel operations.

Are there any questions?

Member: Due to the extreme traffic constraints, was a mid-tunnel siding considered as part of this?

Mr. Dowd: Yes. We considered a mid-tunnel siding. There were a lot of operational concerns. You recognize what's going on with the ventilation characteristics of the tunnel and the fact that ingress and and egress is rather difficult. The other thing we were very concerned about was switches. We actually have the switch locations to the double track main line a quarter of a mile out past each portal. So if we were to put two switches in the tunnel we felt that operationally, it would be a very undesirable set of circumstances. But it was considered and it could be, it's not necessarily a dead issue yet because if the UP decides that we cannot operate the traffic that we project in this tunnel, then we need to rethink some of our proposals. Thank you very much. (Applause)

Mr. Steele: Thank you, Bill, for that excellent presentation. Our next item on the program is a standing subject presentation on new innovations and B&B equipment. Here to introduce this subject are Bill Nelson and Joe Lileikis.

Mr. Lileikis: They say that necessity is the mother of invention. And over the past few years there have been a lot efforts on Union Pacific to actually put together a vehicle for bridge and building work that actually does what you need it to do, instead of something that you have to purchase off a lot. Over the past couple of years Denny Peters has been instrumental in putting together the specifications and standards and actually working with people to put together a truck that works for us.

Denny has been working for Union Pacific for about 22 years and has served the railroad in various disciplines within the engineering department, ranging from working on a survey crew to actually being a B&B supervisor.

STANDING COMMITTEE REPORT

Innovations In B&B Equipment

Ron Jeffree, Berminghammer Corporation
and
Dennis Peters, Union Pacific Railroad

Mr. Peters: After years of having a choice of either track or signal gang trucks my boss, Gene Groves, decided that we needed a specialized bridge and building truck to meet the department needs. I was assigned the task of organizing the design fabrication and purchase of this truck. The objective would be a vehicle that would meet our needs on the road, on the rail and at the bridge site, complying with company rules, OSHA, FRA and DOT regulations.

The basic requirements were: It would need a crane with material handling capabilities at a usable radius, be equipped to comfortably transport gangs of up to ten people, at times for long distances which would eliminate the need for two trucks on a gang. It would have to be designed with enough material-carrying capacity to be able to haul something; be operable from a remote control station outside the cab, allowing it to move on structures in compliance with all the regulatory agencies, especially in the area of fall protection, and be properly outfitted with hydraulic tools and removable tool storage and oxygen acetylene compartments.

The foundation of this project is a Ford LNT-8000 cab and chassis with a 215 inch wheel base. The fully equipped cab features air-conditioning, power steering along with full instrumentation. Power is supplied by a 240 horsepower Ford diesel engine, coupled with an Allison automatic transmission. The chassis has been retrofitted with a reversing transmission for full service, on-track operation. The 34,000 pound Tandum axle offers a pay load up to 13,000 pounds.

The Fairmont hi-rail equipment model, HR-4000 offers conventional rear suspension system in its unique utilization of the vehicle's front suspension, enhanced vehicle ride and safety. It is equipped with air activated, front and rear cobra type brakes. The rear guide wheels have six inch horizontal traversing feature for easily aligning the vehicle with the rail.

A lot of consideration went into the decision to rear mount National's M-85 crane with fully retractable articulating boom. It provides sufficient lifting capacities at our normal operating radius, without sacrificing too much of the vehicle's load carrying capacity. It's folding feature allows personnel access from the rear of the truck. Standard manual controls provide normal off rail boom operation. In addition to the crane remote at the seat of control, a hand held control with 30 feet of cable may be attached at ground level. This will allow the operator to position himself anywhere required.

Outriggers may be controlled from the rear of the truck for under-bridge use, without the operator standing on the side of the truck. The crane is equipped with a 4100 pound hydraulic wench, with 95 feet of cable. It also has a 280 degree rotating grapple and one person fiberglass bucket with 300 pound capacity. Outrigger extensions allow on-rail use of the crane. Stability testing on-rail with outriggers used in a retracted position, provided a load chart allowing 3000 pound capacity at an 18 foot radius.

The eight person McHenry crew cab, suspension mounted, sound insulated, heated and air-conditioned makes job commuting bearable compared to older model sweat boxes. Premium individual seats mounted on storage cabinets and walk-through cab design enhance total comfort of the cab. The centric hydraulic system not only supplies the crane and the hi-rail gear, but a 10,000 pound material retrieval wench with a 150 foot of cable and two 75 foot hydraulic hose rails, capable of supplying from one to 15 gallons per minute, for the operation of spike, driver and puller, drill and impact wrench.

The removable compartments may easily be moved from truck to truck, placed at the job site, or totally removed to allow use of the full truck bed. The compartments are all modular in size, allowing stacking in any order. They are secured by chain and binder to a retractable chain in the truck bed floor.

The oxygen acetylene compartment, with its 100 foot retractable hose rail, may be used on the truck or removed for bottle changing or job site use. The truck may be operated on rail from the seated control mounted on the crane mass. In addition to the crane controls, the operator has transmission shifting capability, with speeds from a minimum crawl up to 6 miles per hour, a chassis parking brake control, as well as pneumatic control of hi-rail service brakes.

The location of the seated control allows excellent vision for both the movement of the truck, as well as material being handled by the crane.

A lot of planning has gone into the safe and easy access, from the rear of the truck, the seated control, the truck bed and the tool compartments for both on rail and off rail use. In addition to normal safety features such as rail grab handles, driving and strobe lights, back up alarm and fire extinguishers, this truck has been equipped with a in-cab audio and visual indicator when the boom is not stowed properly, an outside warning when outriggers are being moved and a radar sensing alarm that sounds if something is directly in front of the truck when operated forward from the remote seated control.

I would like to acknowledge and thank all the Union Pacific Southern Region B&B gangs; Gene Groves, maintenance engineer of structures; Steve Kendrick, manager of maintenance of way equipment and vehicles; Richard Reynolds, manager of safety engineering; Mike Crump from Fleet Body Equipment; Herb Fermon from National Crane; Junior McHenry from McHenry Truck Equipment for their input, help and extra effort in developing a new and one-of-kind railroad vehicle, that effectively serves our department needs, both on rail and off.

I'd like to thank you for this opportunity to share this project with you. If you have any questions now or later, I'll do my best to answer them.

Member: How much does it cost?

Mr. Peters: The next one will be in the $140,000 neighborhood. We spent slightly more than that on the prototype.

Member: If it's going to be a little bit cheaper, are you taking parts off? If so, what parts?

Mr. Peters: No. I guess there's a little bit of R&D in there. But one of the main things we found is that we're going to use a hydraulic reversing transmission along with a manual transmission, instead of the automatic. That's the biggest significant cost savings. We're just getting all the other motions down to where we really know what we're doing with it.

Thank you. (Applause)

Mr. Nelson: Thank you very much for that presentation. On the standing committee we've kind of given a thought to bringing the supply group into some of these presentations a little more than we have in the past. The next presentation is brought to you by a supply manufacturer of bridge equipment. I'd like to have Ken Norton from Osmose do that introduction for us.

Mr. Norton: Bill, thank's very much. Good morning, gentlemen. As Bill mentioned I'm not your next speaker. I'm here representing the Railway Engineering Maintenance Suppliers

Association, otherwise known as REMSA. If you've heard the acronym or the name REMSA mentioned a lot this week, that's good, because that's one of our objectives. I think, really, our objective is to show you the other side of this organization, which is its professional side, and to indicate to you that we're diligently trying to work with you and your companies to make rail transportation the mode of choice. It goes without saying that we all have an vested interest in that.

Your next speaker is Ron Jeffree, general manager and a Director of the Berminghammer Corporation, Limited, headquartered in Hamilton, Ontario. Berminghammer specializes in pile driving equipment. They have been a member REMSA for about 20 or 25 years. Ron was born and educated in England where he attended Stanley Technical College, which by the way is the oldest college in England. He received a higher national certificate, served a five apprenticeship in the tool and dye industry, then immigrated to Canada in 1963, where he has been with Berminghammer more than 13 years.

Ron will talk with us today about innovations in pile driving equipment. Ron.

PILE DRIVING EQUIPMENT

Ron Jeffree

General Manager
Berminghammer Corporation, Ltd.

Thank you, Ken. Good morning. I'd like to talk a little bit about pile driving equipment today and, specifically, hammers. I'd like to go back in history and look at some of the initial hammers. The very old and original hammers, the hand drivers, and work our way up to what's on the market today.

Throughout the ages people have been interested in driving piles. Even nowadays you can see people getting intrigued around construction sites when the pile driving operations are going on. You can't blame them, it's a very interesting subject.

Although the use of the piles date back to ancient times, there's hardly any information available about how things were done. We have records as early as 1200 A.D. about the solidity of foundations when piles were driven into the ground. But it was only in the 16th Century, really, that we got any pictures about pile drivers and the way things were done.

There were three main types of pile driving methods, the Hand Driver, the Common Ram or Dutch Driver, and the Reel Driver.

This is a hand driver, far from what we use nowadays. You see the handles on the side, this allowed four men to raise and drop this hammer onto piles. The steel bands around the bottom were used to stop the piles from splitting. This was made of elm or oak or heavier types of wood, and it was very useful in the driving of short piles, dam boards and fences.

Here you see a couple of fellows trying to drive a pile in by hand. A very slow and tedious procedure. This shows the Dutch, or common Ram method. On the right you see four workers actually using the hand drivers to start the beam. To the left of the picture, a few of the laborers are enjoying their beer, down in the corner, much to the displeasure of the driving foreman, who was trying to organize the rhythm of the driving with driving songs.

The two rams, it's on your left side, the pile gang holds up the ram and they drop it. Now, it has to be done fairly simultaneously. The men would complete about 30 blows, the fall of the ram being about four and half feet. They would then have a drink and short rest. During the driving process, the pile master used to sing, more or less, appropriate tunes to keep the men working. On the 29th and 30th blows he would sing, “High in your bed and then strike and set”.

After the Dutch pile driver, the so-called Reel driver became popular. This differs from the Dutch driver in the fact that a gang of laborers do not have to pull the pile up. It’s pulled up by a machine. The drop hammer can be pulled higher, can be heavier, it disengages automatically and falls down freely. Operating the Reel driver requires fewer laborers. As recorded, the Reel drivers were in use in 1430.

There are many traditions associated with pile driving. Decorating piles, making noise and drinking to a prosperous job were some of them. This is the first pile fully decorated for the foundation of a house in Amsterdam in 1872. The driving master sits with a branch in his hand on the wagon, which will carry the decorated pile to the building site. The laborers are in a good mood. And at that time, driving was done by hand and the master would be singing some driving songs.

In the initial staging of driving, sometimes the pile would sink on the first blow. Gradually the sinking would stop and at the cry of, “strike and set” the last blow was struck. Now, to arrive at a set, they would perform what was called a calendar. That’s a series of 30 rapid blows and at the end of that time, that would be their set. If the pile did not move anymore, they would call that set. The crew would often try and maneuver this last operation, because it was very important to them to get the driving done as soon as possible. And if they had to repeat another calendar to get the set, they’d be very upset. So they became very adapted to slowing down the pile on the 29th and 30th blows, so it had no effect and they could get on with their next pile.

All laborers did their job, more or less, joyfully and there are numerous driving songs. One song they used to sing for their monotonous task was, “Hoisting, hoisting, hoisting high, big brown beams and hand thereby, all of us must have a try”. There are a lot of such songs, most of which were only used when driving was done by hand.

But the gang of drivers would appreciate a small draft is obvious with this kind of work. Several driving songs are based on this theme. Soon the boss will come with a full bottle. Well, in fact, the boss would only come with a full bottle when the first pile was driven. This tradition has not disappeared. When the first pile was driven for the foundation of the King Church in Amsterdam in September, 1854, the laborers got a full glass.

When the last pile is driven, it is very common to detonate gun powder. And, at this time, they would sing to the last pile, as it will never come again. They would then carry the pile around, decorate it and drive it into the ground.

In the course of time, driving songs have died out. Occasionally you hear something like it when they are laying electric cables, which after having been pulled from their reels, they put into the gullies, but this is dying out too. Romanticism has disappeared and functionalism has come instead. One of the many small, but nevertheless, regrettable impoverishments that life has suffered. Although, people still take an interest in driving itself, the driving song is struck down.

In the second half of the 19th Century, people all over the world began to look for ways of making the very hard and slow job of driving by hand a little easier. A company which was set up in 1868 as a boiler factory, established themselves as manufacturers of steam wenches and pile frames, whose falling weight was lifted with the help of chains. About 1880 they started the production of a steam hammer, whose falling weight was pulled up by the means of a valve in a cylinder. This method is still used up to the present time.

Shortly after the Second World War, companies in America, Belgium and England were authorities in this field. The first steam broilers were coal fired. After 1945 oil was introduced everywhere. These steam hammers were very reliable and that is why they are still used, mainly in North America and for foundations of off-shore oil rigs.

In 1926 a German company constructed the first explosion hammer, which lifts the falling weight by means of air mixture. In 1932 one could push up falling weights of over 1,100 pounds. In 1936 they succeeded in lifting the falling weight, with the help of an explosion of diesel oil. In 1938, the actual forerunner of the present day diesel hammer was developed.

After the war this new technique was developed further to what is now referred to as the diesel hammer. The explosion of the air fuel mixture pushes the piston up and while the piston falls a quantity of fresh air is sucked in, coupled with the introduction of the diesel fuel creates an explosion. A later version of this method is the double acting hammer, whose piston is pushed back with great velocity by the air chamber at the top of the hammer.

During the last few years our insight into the pile driving process has been improved and it was found that it was not necessary to always drive with full power. From an energy mechnical point of view, the use of the diesel hammer is preferred, because the energy needed is directly transposed from the fuel. Pressure injection fuel systems gives the possibility to adjust the blow energy of today's diesel hammers. This makes the driving, from an environmental point of view, acceptable.

Just before the Second World War, the Russian government commissioned a Professor Barkin to investigate the possibility of vertical vibration in driving piles. This request stemmed from the problems that steam hammers were having in Russia due to freezing up. In about 1960 three companies in Europe developed the so-called vibratory hammer. The advantages of these hammers and relatively low weight reliability and safety were conclusive.

The development of hydraulic hammer, seemed to many people, a natural and perhaps simple application of hydraulics. Many construction firms built prototypes with mixed successes and failures. It was not until the development of the Hydroblock Hammer, that new waves were felt. This hammer, developed by a Dutch group in the early 1970s, became the first viable hydraulic hammer. It's relatively small power pack and high energy weight ratio made it easy to use.

Larger hammers ranging from one million foot pounds energy up were developed for the North Sea oilfields. These hammers, some as tall as seven story buildings, truly began to make waves throughout Europe.

In 1976 the hydroblock made waves of different sort in Louisiana. The Model NBM-3000, one million one hundred thousand pounds per foot, was used to drive 84 inch diameter anchoring piles under water. The hammer descended to a depth of 1,050 feet and drove the piles to an inbeded depth of 500 feet. The driving time was 65 minutes per pile. These large diameter piles were used to anchor a platform for Shell Oil.

The hydroblocker paved the way and caught people's attention. It also had a lot of reliability problems. The complex system of sliding tubes, which fed oil to the hollow ram while it was moving, was a constant problem, as well as the numerous nuts and bolts and small valving components inside the hammer.

A steady supply of spare parts and competent mechanics was needed to maintain the hydroblock. Today there is a broad range of hydraulic impact hammers available on the market, varying in complexity from very simple to electronically controlled.

There are three basic types of hydraulic hammers. The first is gravity free-fall style. This is simple, straight forward and effective. A Swedish company manufacturers this type of hammer. The solid ram is thrust upward by two hydraulic cylinders. The novelty of this system is that these cylinders are not attached to the ram in any way. Once they are given the initial upward momentum to the ram, the cylinders stop, quickly retract and the ram falls.

Then we have hydraulically assisted free fall hammers. An English company is a notable manufacturer of this type of hammer. The ram in this hammer is guided by two external supports. It has one central hydraulic cylinder to lift the ram. When the piston rod moves to its predetermined distance, the inflow of high pressure fuel is ceased, allowing the ram to decelerate to the top of its stroke. The ram then free falls onto the pile helmet. This also is a simple, versatile and well tested hammer.

The third type is the nitrogen assisted double acting hammer. This hammer uses a nitrogen accumulator to drive the piston down, making it capable of higher frequency. The long ram, of varying diameters, is hydraulically lifted. The downward thrust is composed of gravity fall and nitrogen pressure acting on top of the piston. Ram acceleration is twice gravitational acceleration. This hammer is also capable of driving and extracting under water. A Holland company are the principle manufacturers of this hammer.

This brings us up to the present time. I'd like to look a little further to current problems and possible solutions.

Rating the energy of diesel hammers. Here is where I have my biggest beef with hammer manufacturers. With the type of testing equipment on the market today, the energy output of a hammer can be calculated accurately. Until recently it had been common practice to rate a hammer's energy by the weight of the ram times the stroke of the ram.

So if we take a theoretical hammer with the ram weight of 4,000 pounds and a maximum stroke of 10 foot, that gives us a rating of 40,000 foot pounds. Now, is that a true number? Is it really the potential energy of the hammer? I don't think it is.

Let's take this theoretical hammer. The piston is at the top of the stroke, the potential energy, there's nothing to effect it, so potentially it is 100 percent. The next position, you see the piston is now down to the exhaust ports and in our estimation, we've lost five percent of that potential energy to friction. Now, we have gone past the exhaust ports to striking on the anvil. Once you go past the exhaust ports, we estimate to have lost another 20 percent decompression. So that's a 25 percent loss. So now, the real potential available, at this point, is 75 percent of the rated energy, which is 30,000 pounds, not 40,000 pounds.

In the traditional design, the falling ram compresses and ignites the diesel fuel in the compression chamber, driving the ram up and the impact block down. The impact block makes contact with drive cap around, both through the striker plate and through the cushion material.

There are two problems with this system. The first problem relates to the cushion material. This material is designed to perform two functions, the first function is to absorb some of the energy and transfer the energy to the pile over longer period of time. The idea is to lower the peak forces created by the falling ram, thus protecting the head of the pile.

The second function is to protect the pile driver by absorbing the rebound of the pile, rather than transferring it back to the hammer. This is called racking and can be damaging to the hammer.

In reality, the cushion material absorbs energy and turns it into heat that first hardens and then deteriorates the material. Thus, the pile is robbed of some of the energy that is used to drive it into the ground. In addition, the material does not stop energy being transferred back to the hammer.

The second problem with the existing design relates to the drive cap or anvil weight. To overcome the naturally destructive forces created by the falling ram and the ensuing transferred energy, drive caps, or anvils, are made of durable materials. They are very dense and very heavy. This additional weight, typically between 1,500 and 2,000 pounds, rests entirely on the head of the pile. The pile plus this additional weight must be mobilized before any driving of the pile is done.

In summary, the existing design robs about 65 percent of the kinetic energy of the ram at the point of impact, increases the inertia of the pile and transfers damaging energy back to the pile driver. So if we go back to our position of having 30,000 foot pounds available, if we now have these further losses, what does the hammer actually put out? Testing on various brands of hammers have verified that energy transferred to the pile, range from 30 to 50 percent of the potential, which means that from the initial rated energy of 40,000 foot pounds, only nine to fifteen are being transferred. What can be done?

Well, the latest thing on the market is the direct drive diesel hammer. If we go back to our theoretical hammer, at the impact point, we have the same situation as with the previous hammer, that is 25 percent lost to friction and compression. So we have 30,000 foot pounds available. Now, what the direct drive system does from there on, is what's important. The drive cap, or anvil, is eliminated. The direct drive housing attaches directly to the lower end of the hammer. This allows precise alignment to the pile. The cushioning material is eliminated. The deletion of this material dramatically increases the energy that's transferred to the pile, resulting in faster driving time.

The ability of the direct drive to transfer energy in one direction is important, because the objective is to transfer energy from the ram to the pile. The elimination of the drive cap or anvil also lowers the overall weight of the hammer, improving the energy to weight ratio of the hammer.

Analyzing tests on this system indicate of the 30,000 foot pounds available, 90 percent to 95 percent of the real energy can be transferred to the pile. The faster driving times make this a very effective and profitable tool available to railroads and contractors alike.

Throughout the years there has been many humorous things that have connected with pile driving. I'd like to relate one of them to you. Back in 1982 I had a call from a railroad in the midwest. They called and said, "We have just received one of your hammers and it won't start. We've gone through check list, we checked everything, it won't start." I said, "You are absolutely sure you've done all these things?" "Yes, yes, yes", they said. I said, "Will you do me a favor? Do it one more time." They did and called me back two hours later, it still wouldn't start. "We got to get this bridge driven, somebody's got to come out and help us". I said, "Okay". I jumped on the plane, flew out that night, arrived the next morning.

When I got there, I looked at the hammer and asked them to show me what was happening. They fired it, it wouldn't start. So I climbed up and had a look, immediately saw the problem. On the top of the fuel tank there's a very small breather valve that wasn't open. So pretending not to look at that, I looked up higher and reached down undid the breather valve. I climbed back down and said, "Well, fellows, you know what the problem is? This is a female hammer". And they said, "What do you mean, a female hammer? I said, "Well, you know what females are like, in the morning you give them a little kiss to get them started up". So I went over and pretended to kiss the hammer. I said, "Let's give it a try now". Bang! It started right up.

The looks on their faces was amazing! And I understand that the next morning the foreman did give it peck to get it started! (Laughter) Thank you very much. (Applause)

President Walbrun: Thank you very much for that very fascinating report. This session is now adjourned until 1:30 p.m., when we will reconvene back here. Please remember to fill out the special subject cards for next year's special subjects.

Session adjourned

TUESDAY AFTERNOON SESSION

September 22, 1992

President Walbrun: Welcome to the continuation of the second session of this conference. The attendance as of today is 76 B&B, 143 Roadmasters, 267 suppliers, 122, guests, and 99 ladies registered for a grand total of 707. At this time, I'll turn the program over to Don Steele.

Mr. Steele: Thank you, Mark. I'd like to introduce Dick Dummar, chairman of our special subject No. 4, Regulatory Permits and Code Compliance for Railroad Buildings. Dick has been employed with Union Pacific Railroad for about 11 years in the Architectural Department. He is manager of architectural design. He has worked for several engineering firms before coming to Union Pacific, so he has quite a bit of experience. Dick holds a Bachelor of Architecture degree from the University of Nebraska. In addition to belonging to the B&B Association, Dick is also a member of AREA.

Special Subject No. 4

Regulatory Permits and Code Compliance For Railroad Buildings

Introduction

"If a builder has built a house for a man, and his work is not strong and if the house he has built falls in and kills the householder, that builder shall be slain.

If the child of the householder be killed, the child of that builder shall be slain.

If the slave of the householder be killed, he shall give slave for slave to the householder.

If the goods have been destroyed, he shall replace all that has been destroyed; and because the house that he built was not made, and it has been fallen in, he shall restore the fallen house out of his personal property.

If a builder has built a house for a man and his work is not done properly, and a wall shifts; then that builder shall make that wall good with his own silver."

Good afternoon. My name is Dick Dummar, and what you have just heard was the Hammurabi Code written in 2000 B.C. or thereabouts and was short, to the point, and quite effective in dealing with sloppy builders. There weren't too many change orders or overruns written in those days.

I'm here to talk to you today about regulatory permits and code compliance for railroad buildings. The purpose of building codes and regulations is to provide minimum standards for the protection of public health, safety and welfare. This is done by regulating and controlling the design, construction, quality of materials and the use and occupancy of all buildings and structures. Various zoning ordinances, building codes, and other statutory restrictions that apply to railroad buildings must be identified and understood in the earliest design stages of a project. These restrictions may have significant affects on a project's feasibility, and at times they may be major determinates of form. Legal constraints on site use can also affect the program of a project.

Zoning Ordinances and Building Codes

Zoning ordinances and building codes have distinctly different purposes. Zoning ordinances prescribe land usage and regulate the function, size, and certain exterior aspects of a building. In contrast, a building code deals with the structural and mechanical aspects of a building as they affect public health, safety and welfare. Historically, building fires have caused countless human deaths. The earliest building codes, therefore, were primarily fire-protection codes concerned with preventing fire and saving occupants. In time, other hazards came to be recognized, such as earthquakes, wind storms, power supply failures, and the danger of panic which is likely to occur in crowded spaces. The concern for public health is manifested in codes which deal with plumbing, ventilation, electricity and lighting.

A number of model building codes are in use, including the Uniform Building Code (UBC), the Basic Building Code (also known as the BOCA Code), and the Southern Building Code. I would also like to point out the fact that railroads are international and we must consider the code requirements of other countries that some of you may be building in.

While there are many similarities among building codes, they are not identical, and the owner, or his representative, must comply with the code applicable to the project. The first thing you do is to identify the administrative authority that has jurisdiction in the area you are constructing your facility and which "model code" they have adopted. You can begin your "code search" by starting at the local level; for example, the city permits and inspections department of the particular city you are in.

You may find that some of the larger cities and towns have written and "adopted" their own building codes. This type of information would be found at the local level.

It should also be noted that a municipality usually adopts a particular edition of the code, which remains in force even when a later edition of the code is published. In addition, the code may be adapted with specific additions, deletions or alterations.

If you have exhausted all avenues at the local level, you begin seeking authority at the county or state level. A lot of times, if you are dealing with a small town or are in a rural area, the county would have jurisdiction and its building codes would apply.

The people you talk to at any level usually try to help and provide you the information you need to correctly design your facility and ensure that it meets code. This brings up a point: I must tell you that the interpretation of the code becomes very important. One person may read it entirely differently than you. Also, when your building is completed and you apply for you certificate of occupancy, the inspector may find something that he does not like and you were not aware that it was a violation. Your only recourse is to fix it. Owner beware!

Code Theories

Building codes are based on one of two theories. The first specifies construction techniques, methods, and materials in detail, while the other establishes the functional requirements which a structure must satisfy under specific conditions. The first theory, referred to as a "prescriptive code", is simple to administrate but it discourages innovation. The second approach, known as a "performance code", promotes more imaginative building design, but it may be difficult to administer.

Terminology may vary from one code to another. For example, one code may use the term "exit", while another may refer to "means of egress" and still another may speak of "exitway". Each code includes definitions of such terms, and these must be noted carefully.

Building Code Characteristics

The correct interpretation and application of a building code requires that a proposed structure be classified by the following major characteristics:

- Fire Zone
- Occupancy Group
- Type of Construction
- Siting of Structure
- Allowable Floor Area
- Allowable Height
- Occupant Load

These classifications establish requirements of the code which are applicable to a specific building. Let's discuss some of these requirements:

Fire Zones

The fire zones of a municipality are geographic districts established by the local government which generally comprise three classifications: High hazard, moderate hazard and low hazard. The criteria include: population density, building height, street access and congestion which affect fire department response time, and the fire department's equipment and competence. Buildings in high-hazard fire zones require greater fire resistance and other protective features than buildings located in less hazardous zones. In fact, certain forms of combustible construction are entirely prohibited in high-hazard fire zones. Because certain uses are prohibited in specific fire zones, the investigation of this matter can be critical.

Occupancy Group

The number of occupants and the nature of their activity are important considerations in building codes.

The occupancy classification or use-group of a structure is determined by the activities for which the structure is intended. For example, yard office buildings, crewman's locker facilities, storage warehouses, etc. The degree of hazard in an occupancy is determined by the amount of combustible materials normally present in a building and the form in which those materials are present.

When two or more occupancies are present in the same building, the code usually requires a fire-rated separation between them. The resulting additional construction costs must be considered in preparing budget and cost estimates.

The use of a building is legally designated by a so-called "occupancy" or "use" permit. That designation cannot be changed unless the building is altered to comply with the requirements of the proposed new use.

Type of Construction

All buildings must conform to specific types of construction which are classified according to the degree of their fire resistance. These classifications range from fireproof to frame construction, and they are usually designated by type numbers arranged in progressive steps. A major effect of building codes is that the principal components of a structure - usually the structural frame, floors, and walls - are made fire-resistive. Certain elements of the building envelope, such as the roof and doors, may also be fire-resistive.

The type of building construction permitted in a particular site is determined in accordance with the applicable building code, the fire district in which the structure is located, and the intended use of the building. Similarly, the type of construction specified has a great influence on the structure's height, floor area, and construction materials permitted.

Siting of Structure

The location of a structure on its site must take into account the possible spread of fire to or from an adjacent structure. In this regard, setbacks and alleys can serve as effective firebreaks. The fire resistance required of exterior walls is determined, in part, by the actual (or potential) nearness to structures on neighboring lots. Similarly, openings in exterior walls may be severely restricted or even prohibited, depending on their proximity to adjacent lots and structures.

Floor Areas

Codes normally specify the maximum permitted floor area for a one-story building based on its use, construction type, and fire zone. These maximum allowable areas, however, may be increased in relation to the fire-resistive design of the structure, which is determined by the materials used as well as fire-fighting devices, such as sprinklers. Multi-story buildings, as well, are usually permitted a significant increase in total floor area with the addition of an automatic fire extinguishing system.

If the permitted floor area of a building is inadequate, the building code may permit a larger building to be built if it is "subdivided" into discrete, fire-resistive areas. These areas are established by constructing full-height, fire-resistive interior walls. When this is done, the area between separation walls is regarded as a separate building in order to satisfy the floor area requirements of the code. "Separation walls" must extend from the bottom to the top of the structure to provide the necessary legal division. Of course, all openings through fire walls must be protected by automatic closure devices, as required and described by the building code.

Height

The height of a building permitted by code is generally determined by both its use and type of construction. The incorporation of an automatic fire extinguishing system usually allows an increase in building height. When the most fire-resistive type of construction is employed, the permitted height of a building is unlimited.

Occupant Load

The allowable number of occupants in a building is specified by the code on the basis of use, with a given number of square feet of floor area allocated to each occupant. These values range from approximately 6 to 300 square feet per occupant. The lower figure applies to facilities with fixed seating; the higher figure applies to mechanical equipment rooms and warehouses.

To summarize the preceding building code characteristics, let us consider the example of an eight-story railroad headquarters building of 320,000 square feet located in a downtown area and determine its classification under the Uniform Building Code (UBC):

1. Fire Zone 1 – Due to downtown location.
2. Occupancy Group B, Division 2 – Since its occupant load would likely exceed 300 persons.
3. Construction Type 1 – Since its floor area exceeds the limits of lesser types.
4. Unlimited Floor Area, Height and Number of Stories Because of Type 1 construction.
5. An Occupant Load of 6,933 persons – Based on Table No. 33-A of the UBC, which specifies 30 square feet per occupant on the ground floor and 50 square feet per occupant on upper floors.

Fire Resistance

Fire resistance requirements serve several purposes. The first, and most important, is to permit safe egress of the occupants in the event of fire. A second purpose is to maintain structural integrity and limit the spread of fire long enough for firemen to extinguish the blaze. A third purpose, of somewhat lesser importance, is to provide sufficient protection to the structure so that it will permit later reconstruction.

The major components of a building's structure are assigned minimum fire ratings by the code, depending on the fire zone, the building type, and the use of the building. Fire-resistance values are stated in terms of hours, and are required for the structural frame, the floors, walls, ceilings, roof, doors and windows. These values are generally reduced when automatic fire-extinguishing systems are incorporated. Required fire ratings range from 3/4 to 4 hours. The higher values apply to exterior walls, hazardous areas, and to elements which separate hazardous areas from adjacent areas with large occupancy loads.

Some codes specify in detail the construction of walls, ceilings, and other common building components, which satisfy various fire-resistive ratings.

Exits

A major concern of every building code is the provision of adequate exits from a building. In most circumstances, every building must have at least two individual exits; the total generally increasing as the number of occupants grows. Exits should always be separated in such a way that a single fire or other emergency cannot block all the exits simultaneously.

Minimum widths of corridors, doorways, and stairways are specified by code, based on the use of the building. In some cases, the installation of a full sprinkler system permits a significant increase in the allowable number of occupants per unit of width, thus reducing the amount of circulation space required. Characteristics of required exit routes are usually specified by the code in some detail. These generally include: Length, width, fire-resistance of the enclosing surfaces, permitted length of dead-end corridors, lighting, directional signs, and ventilation.

Despite detailed exiting requirements, building codes cannot communicate to building occupants the critical protection tactics that may save lives. That must be done by periodic fire training and drills, which are exercises often required by municipal law and fire insurance companies.

Other Requirements

The number of plumbing fixtures in a building is normally based on a maximum population expected. Codes also consider light and ventilation for spaces in general, while the ventilation requirements of toilet rooms are specified in greater detail. The required amount of ventilation is expressed in terms of: (1) cubic feet per minutes, (2) minutes per air change, or (3) air changes per hours. The air from toilet rooms, locker rooms and other odorous areas must be exhausted and not recirculated.

Building codes often refer to specialized codes pertaining to individual "trades" such as electrical or plumbing. Where such references are made, performance, quality, and standards must meet the requirements of all governing codes.

Other Codes and Standards

The Life Safety Code

The Life Safety Code is based an the National Fire Protection Association's NFPA 101. This code addresses life safety from fire in both new and existing structures. The Life Safety Code had its origin in the work of the Committee on Safety to Life of the NFPA, which was appointed in 1913.

For the first few years of its existence, the Committee devoted its attention to a study of notable fires involving loss of life and to analyzing the causes for this loss of life. This work led to the preparation of standards for the construction of stairways, fire escapes, etc. for fire drills in various occupancies and for the construction and arrangement of exits for railroad buildings and other structures, which form the basis for the present code.

The purpose of the Code is not directed to fire alone but also covers "similar emergencies", such as explosions, since those also involve being able to leave the structure safely. However, the primary motivating forces behind this code are the need to counter the effect of fire upon the occupants of a structure, the need for occupants to find safety, and the need to provide the structural elements that will ensure safety.

Goals of the Life Safety Code

The goals which the provisions of the Life Safety Code are trying to achieve ensure a reasonable level of life safety in building design and arrangements. Those goals are:

1. To provide for adequate exits without dependence on any single safeguard.
2. To ensure that construction is sufficient to provide structural integrity during a fire while occupants are exiting.
3. To provide exits that have been designed to the size, shape, and nature of the occupancy.
4. To ensure that the exits are clear, unobstructed and unlocked.
5. To ensure that the exits and routes of escape are clearly marked so that there is no confusion in reaching an exit.
6. To provide adequate lighting.
7. To ensure early warning of fire.
8. To provide for back-up or redundant exit arrangements.
9. To ensure the suitable enclosures of vertical openings, and
10. To make allowances for those design criteria that go beyond the code provisions and are tailored to the normal use and needs of the occupancy in question.

Occupational Safety and Health Administration (OSHA)

In 1970, a new set of Federal Standards came into existence. Known as the Occupational Safety and Health Act, it is commonly referred to as the "OSHA" Code.

Among the factors regulated by OSHA are: fire protection, scaffolding, electrical installations, ventilation, exposure to air contaminants, noise, and radiation hazards.

While its original purpose was to provide safe and healthy environments for employees, its practical effect was to create a whole new set of standards applicable to structures throughout the Country. The standards are relevant to all projects during construction and are predicated on the reality that construction work is inherently hazardous.

The Occupational Safety and Health Administration (OSHA) was created within the Department of Labor to:

1. Encourage employers and employees to reduce workplace hazards and to implement new or improve existing safety and health programs.
2. Provide for research in occupational safety and health to develop innovative ways of dealing with occupational safety and health problems.
3. Establish "separate but dependent responsibilities and rights" for employers and employees for the achievement of better safety and health conditions.
4. Maintain a reporting and record keeping system to monitor job-related injuries and illnesses.
5. Establish training programs to increase the number and competence of occupational safety and health personnel.

6. Develop mandatory job safety and health standards and enforce them effectively.
7. Provide for the development, analysis, evaluation and approval of state occupational safety and health programs.

While OSHA continually reviews and redefines specific standards and practices, its basic purposes remain constant.

The Americans with Disabilities Act (ADA)

The most recent development dealing with disability legislation is The Americans With Disabilities Act, or ADA. The ADA is not a building code, it is a Civil Law and is therefore not part of any review process by building officials. Civil lawsuits can be filed by anyone at any time with penalties of $50,000 for the first offense and $100,000 for subsequent violations. The Justice Department will oversee lawsuits filed against businesses that won't comply with the requirements. The overall purpose of the ADA is to make benefits available to the general public accessible to people with disabilities. The Act is divided into five separate "TITLES" as follows:

TITLE I – Employment
TITLE II – Public Services
TITLE III – Public Accommodations and Commercial Facilities
TITLE IV – Telecommunications
TITLE V – Miscellaneous Provisions

Title III deals specifically with the architectural aspect of the Act. The removal of physical barriers in existing facilities, alterations and new construction. Title III prohibits discrimination against individuals with disabilities in the enjoyment of goods, services, privileges, advantages or accommodations in places of public accommodations and commercial facilities which include places of business where employment may occur.

Public Accommodations are defined as private establishments providing goods and services to the general public. Over five million facilities are affected.

Commerical Facilities are defined as non-residential establishments not open to the general public that affect commerce, such as railroad yard facilities, warehouses and office buildings.

Most of TITLE III became effective January 26, 1992. The "big day" for some 43 million disabled Americans was July 26, 1992, as the employment portion of the Act took effect. New public accommodations and commercial facilities receiving a building permit after January 26, 1992, or occupied after January 23, 1993, must meet full requirements of the ADA. Please note that a facility must meet the stricter requirements of either the ADA or the building codes of the particular area where the construction is being done. For example, some jurisdictions require that an elevator be installed in a two-story building, while the ADA does not require elevators in new small buildings; that is those with three stories or less.

The Rules of Access

The Justice Department and a federal access board have issued public-access rules that all public accommodations and any new commercial facilities must follow under the new ADA. Here are certain minimum access standards that companies must meet:

Accessible space and reach – Public areas of a business must be within easy reach of people with impaired mobility, including those in wheelchairs. Under the new rules, firms must have accessible paths of travel, ample passing space in corridors, and sufficient space to move wheelchairs. Merchandise must be within specific reach ranges.

Wheelchairs – For a typical wheelchair, the clearance width must be at least 36 inches in a passageway, and at least 32 inches at such points as doorways. Two wheelchairs need a width of 60 inches to pass each other. Turning space for a 180-degree turn is 60 inches in diameter.

Accessible paths – At least one accessible path must connect all accessible parts of a public place. This route must link transit, parking, and public streets or sidewalks to the building entrance. The accessible route must coincide with that used by the nondisabled public as much as possible.

The slope on an accessible path is considered a ramp if it is greater than 1:20 (a 1-foot rise for each 20 feet of the path).

Floor and ground surfaces on an accessible path must be stable and slip-resistant. A change of up to one-fourth of an inch in the level of a floor is permitted. Changes in floor level of one-fourth to one-half an inch must have beveled edges. Changes in level greater than a half-inch must be accommodated with a ramp.

Elevators – Elevators should be automatic and self-leveling. There must be both visible and audible signals when the elevator arrives. Doors may not start closing until at least five seconds from the signal; they must remain fully open for at least three seconds.

Doors – At least 50 percent of all entryways must be accessible, and at least one must be a ground-floor entrance. Accessible doorways must be at least 32 inches wide with the door open 90 degrees.

Toilet and Bathing Facilities – Measurement requirements are extremely important in the layout of these areas. Toilet stalls must have ample clear floor space of 5'-0" x 5'-0" and must have grab bars.

Lavatories must not be higher at the rim than 34 inches above the floor. Clear floor space of 30 by 48 inches must be maintained in front of the lavatory.

A shower stall, for access, must be at least 36 inches square, have no surrounding obstacles, and have a seat.

Operating controls in toilet and bathing areas must be operable with one hand and not demand tight gripping or twisting.

Work Stations – Areas to be used by employees as work stations should be constructed so that disabled individuals can approach, enter and exit the area. This does not mean that all individual work stations must be constructed or equipped to be accessible. The ADA Accessibility Guidelines suggest that five percent, but not less than one percent of the work stations should be fully accessible.

Summary

Compliance with the ADA requirements is the law. As a law, it will take numerous court tests to actually refine the intent of the Act. In order to avoid being a test case and costly litigation, we must examine the requirements relative to railroad buildings. The law is currently interpreted as an ongoing process. Therefore, we should undertake and document this type of plan of action:

1. Implement a facility survey.
2. Evaluate employee characteristics.
3. Consult with disability groups.
4. Meet with an outside consultant or in-house architects who are familiar with the requirements.
5. Prioritize barriers to be removed.
6. Provide alternatives if barrier removal is not achievable.
7. Implement a barrier removal plan.

At a minimum, the law expects a "good faith" effort from building owners to comply with the new ADA.

Permits and Inspections

No building or structure that is regulated by codes, being local, state, federal, or from other countries, shall be erected, constructed, enlarged, altered, repaired, moved, improved, removed or demolished, unless a separate permit for each building or structure has first been obtained from the proper building officials. Exemptions from these requirements shall be spelled out in the particular jurisdiction where the building is being constructed.

Separate plumbing, electrical and mechanical permits will also be required for each project that is being done. Specialty permits, such as signs, will also be required.

Protection of people and property are the primary reasons for requiring a permit. The permit inspections make sure construction and installations are proper for the protection of the owner, the customers, the employees and adjacent properties. The permit review process also allows the enforcement of regulations governing land usage and density, access to utilities and public services, and off-street parking. This helps conserve property values and promote the health and general welfare of the community.

The owner of the property is legally responsible for obtaining all necessary permits. A contractor or other representative of the owner may secure the building permit for the owner, if it is agreeable with the owner. Also, fees required for the permits must be paid by the owner or shall be included in the contractor's cost for construction.

All new buildings and additions to existing buildings will require submission of plans and specifications to the building officials for their review. These plans must be accurate and adhere to building code requirements. The plan review could take from two weeks to three months, depending on the area.

Conclusion

I have attempted to cover a great deal of information in this report and feel that I have touched on the high points of building code requirements and permits. I hope this report has given you a better picture of how codes affect the outcome of a building and the importance of identifying these codes early in the design process. Thank you. (Applause)

Mr. Steele: Thank you, Dick. It was quite evident that a lot of research went into that.

Our next feature is on the topic of new scale technology, which will be given by Bill Gemeiner who is employed with the Chicago and North Western Transportation Company for 23 years. Bill spent eight years in bridge maintenance, and after weighing the pros and cons, he bid on a scale inspector's job in 1976. He accepted the position of scale engineer in 1979.

Recently Bill's job has taken on a new scope with additional responsibilities, including coordination of bridge inspection activities, as well as monitoring accuracy of the receipt and meter usage at all of C&NW's locomotive fueling facilities. Bill is currently chairman of AREA Committee 34 on Scales. He was instrumental in the formation of the National Industrial Scale Association, serving for two years as its president. Bill.

TECHNOLOGY OF SCALES

William Gemeiner

Scale Engineer
Chicago and North Western Transportation Company

Thank you, Don. As with other aspects of railroading, the rapid advancement of electronics technology has enabled many productivity improvements, resulting in dramatic labor savings for our industry. I'd like to relate to you how CNW has utilized state-of-the-art electronics to introduce efficiency to a traditional bottleneck in the train classification and handling process, the weighing of railroad cars.

In 1983, the Chicago and North Western Transportation Company (CNW) had a coupled-in-motion weighing system in western Iowa that was unreliable, much to the chagrin of the local shippers. The scale weighed individual axles, a design concept that required a great deal of site maintenance; mostly geared towards eliminating the effect of coupler interaction. CNW efforts to solve this weighing problem inadvertently resulted in an advancement of weighing technology that may be useful to other companies.

It might be said that the railroad industry looks at weighing as a "necessary evil". The delays associated with switching a car to a scale track for weighing sometimes seriously affects transit time. Once cars arrive at the scale, either the train crew sits around, waiting for the clerk, who does the weighing, or vice versa. All these delays and their associated costs have a negative impact on our competitiveness with other carriers and transportation modes.

To summarize CNW's situation in 1983, we had an unreliable scale at a terminal where a large number of shippers required weights before their cars could be shipped. Weighing delays were costing both CNW and our customers a great deal of money. Shippers' insistence that this problem be resolved eventually reached the highest level in our company, resulting in support of the Scale Department's plans to install a 70 foot, uncoupled-in-motion scale. Having received this support, the Scale Department was determined that the new scale would be reliable. We discussed the situation with our weighing equipment supplier and came up with the concept of designing a diagnostics system that could be accessed remotely, using a modem and a personal computer. The implementation of this remote diagnostics package was the springboard that propelled the development of CNW's centralized remote weighing system. This ability to use terminal emulation over a telephone line to check diagnostics had provided us with the means to control the entire weighing system.

When the CNW's stations and customer service department became aware of the capabilities of this weighing package in early 1985, it wasn't long until the remote weighing concept was being used as a "tool" that helped facilitate the consolidation of CNW's clerical functions. Traditionally, and per union specification, the actual weighing, or at least generation of the scale ticket, is a clerical function. Our remote weighing capability allowed clerical forces to be consolidated in yard control centers (YCC) at three locations across our system. As you can imagine, development and implementation of this kind of technology is not "pain free". As with all keyboard-controlled functions, if you put garbage in...you get garbage out. If the wrong car number or tare weight is entered, corrections are going to be necessary at some point down the line, resulting in more lost time. From the beginning then, one of the long range goals of this project was to increase the accuracy of the weight data by reducing key stroke errors.

In 1987, the CNW railroad conceived a consolidation plan that envisioned centralized management of yard-related activities. In essence, all the "paperwork functions" were moved into YCCs in Boone, Iowa; St Paul, Minnesota; and Milwaukee, Wisconsin. A weighing desk was established that had the ability to control multiple scale locations. One clerk could easily handle the weighing chores for six or more weighing locations. Once the cars were weighed, he still had to take the weight data and re-key it into our mainframe billing program. Another one of our weighing program goals, therefore, was to integrate weight information with other railroad computer applications.

There are currently 21 CNW weighing installations under remote control, some of which are more than 1,000 miles from a YCC. It should be understood that CNW has applied this technology to lever system-style scales, as well as electronic weighing systems. Fifteen of our installations are static scale sites; three are uncoupled-in-motion; and three are coupled-in-motion. Several of the lever system-static scales are in excess of 50 years old.

There are three common elements to all scales;

1. A steel weighbridge upon which the running rail is secured.
2. A sensing element that transmits a change in balance condition.
3. A weight indicator usually either a mechanical balance beam or an electronic indicator.

Under the concept of the new system configuration, the following is necessary:

1. Weighbridge and sensing element (when a lever system is used, a load cell is installed between the levers and balance beam).
2. Instrumentation with remote-control electronics.
3. Modem
4. Personal computer
5. Printer

I'm going to briefly explain the procedure for weighing cars at a static scale site. To facilitate your understanding, I'm going to use my laptop computer and overhead projector to actually connect with one of our weighing systems to give you a step by step run down of the procedure.

1. The switching crew moves a group of cars requiring weighing onto the scale track, stopping short of the weigh rails.
2. The switch foreman enters the scale house and calls the Yard Control Center (YCC) on the telephone, advising that he has X number of cars to weigh.
3. The clerk at the YCC calls the scale via a personal computer and enters a password to gain access to the system. The scale is switched from STANDBY mode to WEIGH mode, a procedure which balances the scale, and runs a self-diagnostics check for various system parameters.
4. The clerk now instructs the switchman to place the first car onto the scale. While this is happening, the switchman relates car number, tare weight, and load limit information to the clerk, who keys it in.
5. The upper left corner of the clerk's PC screen has a live weight indication. While the weight is incrementing upwards, "MOTION" is displayed under the weight, and the PRINT is disabled. When weight stabilizes, the clerk uses the PC's keyboard to send a command to the scale system to store the weight of the car and generate a printout.
6. If the car is too long to fit on the scale in a single draft, the clerk has the switchman place the first half of car on weighrails. After the weight stabilizes, he presses a key that stores the first draft. The bottom center of the PC screen displays HALF-WEIGHT ACCUMULATED XXXXXX LBS. The second half of car is then positioned on the scale. When the second half is weighed, the printout indicates 2 DRAFT behind the weight.
7. Each time a car is weighed, the PC subtracts the entered TARE weight from the GROSS weight. This net weight is compared against the entered LOAD LIMIT. If the net weight exceeds the load limit, a HEAVY indication is printed after the weight.

8. When all cars have been weighed, the car information is reviewed for correctness. If everything appears normal, the weights are transferred into an internal scale database. This car weight information can be accessed later, should a question arise.

From a maintenance point of view, the remote diagnostics has been invaluable. The standard message we receive about scale malfunctions is simply..."The scale does not work." Previously, there was no way of knowing if the weighing system was not operating properly or whether the clerk simply didn't know how to operate the scale. Now, CNW scale inspectors have laptop computers with internal modems that enable them to connect with a "malfunctioning" scale to check its operation. This can be done from home, a motel room at night, or anywhere there is a telephone line jack available. This feature has eliminated many unnecessary trips to outlying locations.

Although it is not necessary, many times it is advantageous to link the weighing system with a mainframe information system. We are using a "cut and paste" software program that mechanizes the process of entering car number and tare weight information into the weighing system prior to weighing. A short time before weighing, the clerk goes to a personal computer screen that requests the yard location, track number, and N/S or E/W orientation for those cars that will be weighed next. The "cut and paste" software will direct the inquiry to our main frame computer Yard System and retrieve the car numbers. It then matches the car numbers with tare weight and load limit information from the AAR UMLER Car Listing. This information is then "pasted" into the default directory of the scale controlled P.C. When the YCC receives a call from the switch crew, advising that they are ready to weigh, the clerk calls the scale and enters his password. Upon receipt of a valid password, the car information is automatically inserted into the entry screen, saving clerical time and eliminating keystroke errors. After the weighing has been completed, the "cut and paste" software will update several mainframe programs, including our Yard System and Autobill. An exception report is generated for such things as bad car numbers, "no bill", or overloaded cars.

There are five things that should be considered in anticipation of this kind of an upgrade.

1. Scale house modifications – It is important to provide a protected, ambient environment for the scale electronics. A number of our scale houses were marginal, based on their age. These were completely rebuilt. In each case, the scale house was insulated, and 100 Amp electrical service installed. Thermostatically-controlled heating and air conditioning was also installed. A number of the installations have an alarm system to advise when temperature is not within the desired range of 65-75 degrees Fahrenheit. Two phone lines are installed, one for the modem and one for voice communication.
2. Surge protection and grounding – Any device attached to railroad tracks is likely to experience lightning induced electrical surges. There is no such thing as "foolproof" or "guaranteed" lightning protection; and CNW, like many companies, has experienced more than its share of lightning-caused damage. In 1988, a CNW Quality Team recommended that each site be evaluated, prior to determining the extent of protection for that location. Extensive surge protection of incoming power is used at all locations. A high quality, combination modem/AC protector is installed downstream of a constant voltage transformer. The load cell(s) are protected using a specialized, in-line protector. The entire installation is brought to a common ground, including the approach and exit rails. After grounding is complete, and occasionally thereafter, the grounding grid is tested by our C&S Department to insure that our standard of maximum 5 ohms to ground is still being met. Sometimes locations with sandy soils are difficult to bring within our ground-potential standards. CNW has had good success using a bentonite slurry encasement of the ground rods to accentuate moisture retention, which has in every case improved the ground potential dramatically.

3. Scale instrumentation – The digital indicator we use meets all the requirements of the National Type Evaluation Program and is housed in a durable, water resistant enclosure. This enclosure is a steel cabinet measuring 24 inches by 18 inches by 12 inches and is bolted to the wall. An industrial remote display on the front panel displays the weight. There are a series of connectors on the side panel to allow connection of the modem, as well as provisions for temperature and intrusion alarms. There is a reset key on the lower front panel that allows for a "system-reset" of the electronics. The re-set key can be used to locally re-zero the device.
4. Telephone lines and modems – As the remote weighing system was developed, it became increasingly clear that "noisy" telephone lines were a major impediment to the overall reliability of the system. Spurious characters generated by noise on the line caused many problems with the software control program, and in numerous instances "locked up" the whole system. Realizing that line quality will vary based on many factors, we tried using the new generation of modems that have built in error checking and correction. These new modems, which use the MNP error-control protocol, are now installed on all of CNW's weighing systems and have eliminated the problems associated with marginal line quality.
5. Training and documentation – As soon as the equipment has been installed, it is important that all affected persons receive adequate training. A simple, sequential guideline is posted at the scalehouse for the switchmen's benefit. The operational features of the scale are explained briefly at the YCC for the benefit of the clerical forces. When the remote capability was introduced to each YCC, I used the laptop computer arrangement I'm using now to display the scale control screens in a large size format on the wall. We sample weighed several cars and there was sufficient opportunity to ask questions.

Likewise, it is important to train the scale inspectors and C&S personnel who have to maintain the equipment. Design concepts are briefly discussed, and a good half day is spent going over trouble-shooting techniques.

When specifications are written for a custom designed system such as CNW'S, it is important to have well written, organized documentation. The better the electronics package you purchase, the better your documentation should be. If this sounds odd, just think about it. You buy a high operation. The equipment purrs like a kitten for 18 months, whereupon it fails. By this time, chances are the technician has forgotten 75 percent of what he learned at the training seminar. Your man is going to rely on the instrumentation documentation . . . so it had better be good.

At the end of 1991, all primary CNW weighing locations were under the control of one of the three YCCs. Beginning in December, 1992, the three YCCs will be consolidated into a central facility located in Chicago. From that time on, all rail-car weighing on CNW will be controlled from that single location. In the past 12 months, more than 50,000 railroad cars were weighed by remote control. Now that there is an established base of qualified weighing system operators at the YCC, calls about scale malfunctions are becoming much less frequent. CNW scale inspectors and C&S personnel are familiar enough with the operation and design of the scale electronics that when a scale DOES fail, the problem can usually be diagnosed and the repairs done in house. Six locations are utilizing the "cut and paste" software, automating both car information input and the further keying of weight data into our billing and yard systems. We continue to modify the software that controls the weighing operation. Plans are underway to install new hardware that will allow subsequent software modifications remotely, via modem. This will further reduce "windshield time" for upgrades and trouble shooting of reported weighing problems.

This concludes my presentation. If anybody has any questions, I'd be happy to answer them later at the break. (Applause)

President Walbrun: Thank you, Bill. It is certainly an innovative use of current technology. At this time, I'd like to call upon our immediate past president, John Horney, to introduce the past presidents who are in attendance today.

INTRODUCTION OF PAST PRESIDENTS

***Left to right:* J.M. Williams, W. C. Sturm, J.R. Williams, J. Budzileni, D.J. Lewis, R.A. Tallent, J.J. Horney.**

Mr. Horney: Thank you, Mark. For all of our past presidents, as I call your names will you please come up to the front of the podium. Wally Sturm, senior project engineer, Elgin, Joliet and Eastern Railway, President 1978-1979; Jack Williams, vice president, Alfred Benesch, President in 1975-1976; Jim Budzeleni, retired senior structural Designer., Illinois Central Gulf Railroad, President 1983-1984; Jim Williams, retired supervisor B&B, Elgin, Joliet and Eastern Railway, President 1984-1985; Don Lewis, bridge construction engineer, Illinois Central Railroad, President 1987-1988; Ray Tallent, process engineer track, Norfolk Southern, President 1988-1989.

And if you'll give me just a minute, I'll come down there and join you, because I'm a has-been too.

President Walbrun: John is currently with Amtrak. On behalf of the Association I want to thank all of you for being with us today. And not only for your past service, but for your continuing interest in the Bridge and Building Association. I suggest we give them all a round of applause. (Applause)

As past president and chairman of the Nominating Committee, John will now present the slate of candidates recommended by the committee for consideration as officers.

NOMINATING COMMITTEE

Mr. Horney: Thank you, President Walbrun. Now, as I call your name as a nominee, I would like to have you come forward to be recognized. The nominees are as follows: For president, Paul Saletnik, engineer of buildings, Chicago and North Western Transportation Company; for senior vice president, Don Steele, manager of bridge construction, Union Pacific Railroad; for two junior vice presidents, John VanHuis, chief engineer of structures and production for Wisconsin Central, and Mike Bradley, project engineer for Conrail.

For our Directors with terms expiring in 1995: Lee Hostler, structural engineer, Santa Fe; Jimmy Neece, supervisor of bridge and building, CSX; and Ron Kaye, senior project engineer of structures for the Elgin, Joliet and Eastern Railway.

President Walbrun: Thank you, John. You have heard the slate of nominees recommended by the Nominating Committee. If there are no other nominees from the floor, I will accept a motion that the slate submitted by the Nominating Committee be elected.

Member: So moved.

President Walbrun: Do I have a second?

Member: I second.

President Walbrun: There's a motion made and seconded for the slate of candidates recommended by the nominating committee be elected to the office as specified. All those in favor signify by saying aye.

Members: (In unison) Aye.

President Walbrun: All those opposed? The ayes have it. I hereby declare these officers duly elected. (Applause)

Mr. Horney: As past president and chairman of the Nominating Committee I have another duty I have to perform, and that is to fill a vacancy for an honorary member, due to the death of Herb Wilson. Herb joined the B&B Association in 1953 and was elected to the Board of Directors in 1960. He served as our president for the 1965-1966 term. Herb also served on the Audit Committee for several years. He passed away in North Carolina on August 9, 1992.

The Nominating Committee recommends that Jim Williams be appointed a honorary member. Jim has been a member since 1963, served as president for the 1984-1985 term, and treasurer until just last year. Jim and his wife Margaret have always been available to assist at the registration desk during our conferences. At this time, I'd like to ask President Walbrun to ask the members to approve Mr. Williams as an honorary member.

President Walbrun: Thank you, John. You've heard the recommendation from the Nominating Committee to fill the position for honorary member. I'll accept a motion to elect Mr. Williams as an honorary member.

Member: So moved.

President Walbrun: We have a motion. Do we have second?

Member: I second.

President Walbrun: All those in favor signify by saying aye.

Members: (In unison) Aye.

President Walbrun: Opposed? The ayes have it. The motion carries. Jim Williams is hereby elected an honorary member. (Applause)

We will now move on to the business session. Pat Weissmann is our secretary. She is also secretary for the Roadmasters and Superintendents as well.

SECRETARY'S REPORT
September 1, 1991, Through August 31, 1992

Total members, September 1, 1991		771
New members since September 1		79
Reinstated		2
		852
Less: Dropped - Active	42	
Associate	9	
Life	1	
Deceased - Life	8	
Honorary	1	61
Total members, August 31, 1992		791

President Walbrun: Thank you, Pat. Our membership has been holding steady for over ten years now at that level. We will now hear a report from our treasurer, Don Lewis.

TREASURER'S CASH REPORT
September 1, 1991, Through August 31, 1992

Checking account balance, September 1, 1992		$ 4,998
RECEIPTS		
Dues	$12,015	
Advertising – 1990	3,725	
1991	5,225	
1991 confernce proceeds	2,459	
Bridge inspection seminars	29,000	
Interest on checking account	316	
Miscellaneous	310	53,050
Transfer from money market		5,000
		58,050
		63,048

Disbursements		
Salaries	$10,656	
Payroll taxes	838	
Employee savings	319	
Office rent, utilities & insurance	2,145	
Office supplies	408	
Equipment purchase, rent & repair	569	
Stationery & printing	2,092	
Postage	3,505	
1991 conference expenses	833	
1991 proceedings	12,099	
100th anniversary celebration	5,944	
Executive committee meetings	1,892	
Bridge inspection seminars	14,065	
Temporary office help & cnstltnts.	338	
Miscellaneous	232	55,935
Checking account balance, August 31, 1992		7,113
Funds on deposit with Advance Bank		32,244
Total funds, August 31, 1992		$39,357

President Walbrun: Thank you, Don. Jack Williams is the Chairman of the Auditing Committee and he will now give the auditing committee's report.

AUDITING COMMITTEE

To: Members of the American Railway Bridge and Building Association

Gentlemen:

The undersigned have examined the books of the secretary and report of the treasurer for the period September 1, 1991, through August 31, 1992, and have found them to be correct as of August 31, 1992.

/s/ J. R. Williams, Chairman
W. C. Sturm

President Walbrun: Jack, thank you very much. I would also particularly like to thank the Committee for taking the time to go to the Association office. That's quite a lot of effort to audit the books every year, and they don't have a lot of space to work in.

Doug DeBerg, chairman of the Necrology Committee had to leave so I'll present that report.

NECROLOGY REPORT

To the President and members of the American Railway Bridge and Building Association:

It is with grief and regret that we report the known loss of nine members through death during the past year. It is possible that other members have passed away during the year of whom we have no information. If you have any additional information, please report their names to the secretary. The following have been reported since our last conference in 1991.

Melvin Barsema
B&B Supervisor (Retired)
C&NW Transportation Co.
Joined 10-15-58; Died 11-7-90

L. D. Langham
Division Engineer (Retired)
AT&SF Railway
Joined 12-8-64; Died 10-18-91

B. R. Meyers
VP Engineering (Retired)
C&NW Transportation Co.
Joined 2-1-30; Died 2-28-91

W. D. Ostrom
Chief Carpenter (Retired)
CMStP&P RR
Joined 6-16-54; Died 7-30-92

John R. Safley
B&B Supvervisor (Retired)
SP Transportation Co.
Joined 7-24-45; Died 11-23-91

Alton F. Stade
Engineer Bridge Maintenance (Retired)
SP Transportation Co.
Joined 9-12-62; Died 8-4-92

Edward O. Tustin
Supervisor B&B (Retired)
IC RR
Joined 12-10-62; Died 3-24-92

E. G. Tyckoson
Chief Carpenter (Retired)
CMStP&P RR
Joined 10-15-54; Died 12-02-91

Herb M. Wilson
President (Retired)
F. K. Ketler Co.
Joined 10-5-53; Died 8-9-92

Mr. Wilson was president of the B&B Association in 1965-1966 and an honorary member since September, 1986.

I would like to ask for a moment of silence in honor of our deceased members.

Respectfully submitted,

Doug DeBerg, Chairman

President Walbrun: Are there any questions regarding these reports as presented by the secretary, the treasurer or the auditing committees? If there are no questions or discussion, I will entertain a motion that these reports be approved as given.

Member: So moved.

President Walbrun: Do we have a second?

Member: I second.

President Walbrun: A motion has been made and seconded. All in favor signify by saying aye.

Members: (In unison) Aye.

President Walbrun: Opposed? The ayes have it. The motion is carried and the reports are approved.

Our next presentation will be introduced by Don Steele.

Mr. Steele: Thank you, Mark. Our next feature concerns safety on the job site and the planning and use of proper safety equipment. This feature will be presented by a representative of the Sinco Group located in East Hampton, Connecticut. Sinco has various departments that deal with the construction industry. Pete Giglio is with the Construction Safety Products Division. Pete has been with this firm for four years and is a taking an active stance in the safety and well being of others. So with this, I'll turn this over to Pete.

FALL PROTECTION AND DEBRIS COLLECTION

Peter Giglio

Manager Safety Products
Sinco Products

Thanks, Don and good afternoon to everyone. I'd like to take a moment to offer a short anecdote that relates in some small fashion to our issue of reducing worksite injuries sustained from falls and promoting a safe work environment. It just so happens that there were two friends who decided to take a vacation together backpacking in the Northwest. While on vacation one day, they were out hiking along side a beautiful trout stream. As they rounded a bend in the river, they came upon a huge brown bear fishing there. Well, the bear reared up and appeared to be getting ready to attack. One of the backpackers, making a quick assessment of the situation, quickly sat down, stripped off his heavy hiking books, whipped out a pair of tennis sneakers and put them on. Well, his partner looked at him like he was crazy. He says, what are you putting on sneakers for? Everyone knows you can't outrun a bear. And as he skidaddled away, looking back over his shoulder as the bear attacked, he said, "I know I can't outrun the bear. I don't have to, I just have to outrun you." (Laughter)

There's a message there somewhere. The survivor had some things working for him that the deceased did not. First of all he recognized there was a problem; secondly, he had a plan to deal with it; thirdly, he was prepared with the right equipment; and lastly, he took the time to actually execute his plan. These four elements, problem recognition, planning, preparedness and execution are the key prerequisites for successfully reducing jobsite injuries and fatalities from falls.

Before I became involved in the safety business, my experience in providing safety was acquired in a tangential fashion. As a Marine Platoon Commander in Vietnam a primary objective was to ensure the safe return of my men. This required a lot of preplanning, experience, and of course, good luck. Spending nine years as an air traffic controller solidified my natural instincts to keep things safe, through operational planning. After being terminated as an FAA controller for participating in the PATCO strike in 1981, I innocently entered the construction industry as a laborer with a concrete cutting contractor in the Boston area. Having come from an environment where safety was of paramount consideration, I was not prepared for the ambivalence and occasional arrogance demonstrated when safety issues surfaced at my new position. Conditions that were potentially very unsafe were regularly ignored by managers. The macho attitude exhibited by many of the trades served to exacerbate these situations. I fell into the mold "Go along to get along."

So many contractors and their employees seemed to just go along to get along. Many building and facility owners often times remained ignorant of the peril waiting to befall them in the guise of third party liability. The intervening ten years have brought about significant change. New laws, regulations and standards have opened eyes that in the past had remained closed. Industry awareness of the significant costs and resulting losses from poor safety management is ever increasing. I hope the next few minutes will prove to be beneficial in helping you plan to manage your safety problems.

The purpose of this presentation is to speak about your construction site safety problems. We shall identify some methods for reducing the occurrence of deaths and serious injuries due to employee falls, or damage resulting from things falling on people or property.

To set the stage for an update on the latest fall protection systems, I wish to offer a brief overview as to why an understanding of worker's compensation and third party liability is essential for you and your site safety managers to effectively manage safety at your project sites.

As managers, we must all ask ourselves the question: Are fall hazards really a problem? If you, as an owner or contractor, have had to ask someone under contract to you: "Will you perform your work safely?" The answer received will invariably be yes. Then why are there so many construction relation injuries and fatalities? Some people truly fail to recognize that a particular condition may post a serious hazard. Others recognize the hazard, but are willing to roll the dice and take a chance that an accident will not happen. All too frequently we hear comments such as "I've been at this job ten years and never had anyone fall." Do injuries always happen on the other guy's job? However, fatalities and injuries resulting from falls do occur regularly. Recent fatalities at the O'Hare Airport and Denver Airport construction sites, and a pedestrian fatality right here in downtown Chicago attest to that fact. OSHA Region 8 (Colorado, Montana, the Dakotas, Utah and Wyoming) has instituted a 100 percent fall protection program in response to these fatalities.

An effective fall protection program can evolve only when an owner/contractor agrees that a fall hazard exists on his project, and then implements and manages a program that enlists the cooperation and requires the participation of his managers and employees. Most contractors recognize that the construction industry has an extraordinary safety problem. Why not? It is an extraordinary industry, with much inherent danger. How dangerous? Let me relate three telling facts.

1. National Safety Council statistics indicate that the construction industry is the worst offender in lost time injuries. Figures for 1990 show 6.55 million work days lost, or the equivalent of one year's labor by 41,600 workers.
2. The construction industry employs approximately 5.4 percent of the national work force, but accounts for 20 percent of all job-related deaths.
3. On an average day, there will be eight fatalities and 840 injuries on U.S. jobsites.

These statistics serve to illustrate the resulting pain and suffering for victims and their families with the commensurate lost time, lost production, and lost revenue for employers. How significant are the problems concerning all related injuries and deaths? Falls from elevation account for the largest percentage of all construction fatalities. From 1985-1989, 33 percent or 1,148 of 3,496 fatalities resulted from falls from elevation.

There are two obvious reasons why we should have an interest in reducing these incidents. First, because of our humanitarian and moral obligation to provide a safe environment for employees and the general public. Second, by maintaining an effective fall protection program, you will help to keep your business competitive and profitable. Let's discuss the latter:

We all have a general understanding that workers' compensation claims and associated costs are on the rise, but let's get specific:

- The National Council on Compensation Insurance statistics show that from 1985-1990 compensation rates have increased 70 percent.
- In 1982 U.S. businesses paid approximately $23 billion for workers' compensation. The 1990 figure totaled an astounding $60 billion.

Let's look at one example that we can all relate to. Let's talk for a minute about an actual $20 million construction contract. The labor cost was $8.9 million, and the profit on this contract was three percent, or $600,000. This company's workers compensation modifier was 1.2 percent or $496,984. Should, through good safety management and planning, the modifier be reduced to .6 percent, the workers compensation rate would be $248,482, a savings of $248,502, or almost a 50 percent increase in the profitability for the project. Should the modifier move 50 percent in the opposite direction to 1.8 percent, the compensation costs would increase to $745,466 resulting in no profit and a loss of $175,000. Obviously, in this case, as in practically all construction contracts, workers compensation costs can be and are the difference between good profit and no profit. Owners, having been stung by the bee of third party liability, are starting to require that contractors disclose their modifier rates, and in many instances they are throwing out bids from companies where MOD rates exceed the norm.

Let's discuss the direct and indirect costs of jobsite injuries. Workers, compensation and medical expenses resulting from jobsite injuries are direct costs, and as previously noted, they are substantial. The $60 billion spent annually on workers compensation could fund construction and rehab on thousands of bridge projects nationwide. However, as colossal as these direct costs are, they pale in comparison to the indirect or hidden costs. These hidden costs result in liability lawsuits, loss of production and lost time by supervision (such as, accident investigation, court time, time lost completing required reports, time lost preparing for and dealing with an ensuing OSHA inspection). The losses quickly eat up hard earned profits.

By far, the most costly of these hidden burdens is third party liability claims. Most state compensation laws prohibit an injured worker from suing his direct employer. However, owners, construction managers, and general contractors are "fair game". The Stute Decision recently adjudicated in the state of Washington, lays the responsibility for job safety squarely on the shoulders of the general contractor. This will result in more liability exposure and cost for those general contractors who don't properly manage their subcontractors on-site. Even when suits are successfully defended, the costs for attorney's fees and time lost from work remain high.

Let me recount two recent cases of third party liability that illustrate the potential for substantial hidden costs.

1. Reported in the Washington Post June 19, 1991 - a plumber was struck and seriously injured by falling debris. The general contractor and two subcontractors paid an immediate $4.5 million with subsequent payments that could total $13 million if the injured party lives until the age of 75.
2. Reported in the Boston Globe July 9, 1991 - an iron worker fell 40 feet and was severely injured. The court awarded a $4 million judgment against the Joint Venture general contractors.

Owners are not safeguarded from the long arm of third party liability. Our company, Sinco, routinely represents some of the largest employers in the United States in defense of third party liability suits. Presently, one of the largest U.S. manufacturers and its construction manager are involved in a suit resulting from a severe injury sustained by an iron worker from a fall. The steel erector involved is incurring the direct costs, workers compensation and medical expenses. The owner and the construction manager will bear the burden of any third party liability.

It may be very substantial.

Now let's look at the ways to control your costs and profits by examining the ways to reduce fall related injuries and fatalities.

Planning

The first and foremost ingredient for successfully reducing fall-related injuries and fatalities is planning. New standards and laws are requiring preplanning for site safety.

The recently published ANSI Standard A-10.33 points us in the right direction for establishing a written site specific program addressing jobsite safety. The state of Washington requires a written fall protection plan for all jobsites and supports the requirement with a state standard for fall restraint and fall arrest. The key to success here is preplanning. You must take the time to identify fall hazards and give some thought as to how you will manage them. Ideally, this process does not begin on the day the hazard begins to pose a threat. Successful preplanning begins in project estimating, particularly where significant problems of fall protection are apparent. The solutions that are simple, user friendly, and accommodate worker productivity will be the most effective.

Have your contractor or subcontractor prepare a written site specific fall hazard analysis, then prepare a written site specific plan for fall protection. Remember, injuries and property damage can occur from objects falling from elevation, recognize these situations during your analysis.

Let's contemplate the possible solutions to fall hazard problems:

1. The most foolhardy and costly approach is to do nothing.
2. Another option commonly used to meet the requirement is to restrict the fall distance by installing a platform or decking. Have you really solved the problem? As an example, on a tiered building the Federal requirement allows for no fall to exceed 25 feet. Certainly a 25 feet free fall in all probability would cause serious injury or even death; even a short fall onto planking often times results in lost time injuries. Again, I ask in these situations, have we really solved the problem?

Now let's talk about the pro-active alternatives: active and passive fall protection systems. The systems not only meet the requirement of the law, but afford the person falling a real chance of surviving a fall and returning immediately to work.

What are active fall protection systems? In order to be effective, an active fall protection system will require a positive action on behalf of the user. Some examples of active fall protection systems are safety harnesses, lanyards, retractable lifelines, horizontal lifelines, rope grabs, etc.

When selecting active fall protection systems, you should opt for equipment that is user friendly and compatible. Use the old KIS rule - "Keep It Simple" - equipment that is easy to use, and allows work to be performed in the customary fashion is more likely to be used. Equipment that is difficult to use may require an added measure of supervision to ensure that it is used. Regularly scheduled training on the use and maintenance of active fall protection equipment is a must. Equipment improperly worn, used, or maintained may result in serious injury or death.

What's new to help your people in the field? I'm sure you are all familiar with the double locking snap hook. The double lock action was designed to eliminate roll out that has occurred all too frequently with the old single action snap hook. The problem is that the double lock can be difficult to operate, particularly when the user is wearing a pair of gloves for protection against extreme temperatures or work conditions. On many occasions you will notice workers wearing safety equipment, yet they are not tied off. They frequently cite the cumbersome action required to operate the double lock snap hook as a reason for not tying off. In these instances, a $7.00 snap hook that is a component part of a $150.00 fall protection system is, in essence, rendering the system useless, wasting money and increasing the risk that you, as managers, are trying to reduce.

A new safety hook that is user friendly is now available to help minimize these problems.

In summary, active fall protection is most effective when the equipment to be used is user friendly, and when exposure to the hazard will be for a few employees and the duration of exposure will be short. Regular training and vigilant supervision will help make the use of active fall protection systems most effective.

Let's talk about another alternative for addressing a fall hazard: passive fall protection or personnel safety nets. A netting system can be installed to remedy two fall hazards.

First, as a fall protection system for employees working over the netting system.

Second, when a personnel safety net is equipped with a debris net liner it will contain falling debris, protecting people, property, or environmental concerns below.

What is a personnel safety net? A simple definition, details to be found in OSHA 1926.105, requires a mesh of not more than a six inch square that has been prototype tested to capture a dynamic load of 17,500 feet per pounds.

When does the use of passive fall protection make the most sense? As a general rule, passive fall protection systems make the most sense when a fall hazard exists that will require substantial exposure to many employees, particularly when a hazard will pose a threat to multiple trades, and the duration of the exposure may be prolonged.

Let's talk about some of the advantages of passive systems:

1. When passive fall protection systems are in place the protection is there for all who work over the nets - active fall protection systems can only protect the user.
2. A single installation can provide protection to multiple trades, negating the need for each sub to provide an independent fall protection system.
3. Safety nets, particularly nylon cord netting, will absorb energy generated during a fall. Netting systems provide a soft catch, reducing the likelihood of an injury resulting from an arrested fall.
4. Passive fall protection systems facilitate your site safety management requirements by reducing supervisory time required to support active fall protection systems. This allows site safety managers additional time to respond to other safety problems or to conduct safety training.
5. When a debris net is incorporated with a personnel safety net the resulting benefits are:
    - Fall protection for workers over the system.
    - Protection from falling tools or construction debris for employees working below the nets.
    - In areas that may be ecologically sensitive, or where public safety may be at risk or damage to adjacent property is a possibility, a netting membrane can be a very effective tool for containing debris as well as protecting workers over the net system.

Conclusion

In conclusion, we can all see fall hazards are not problems to be ignored. When not properly managed, they can prove to be very costly.

The recipe for successfully controlling and reducing your compensation costs, while increasing profit on your projects, includes the following ingredients:

1. Recognition of jobsite hazards.
2. A plan to manage them.
3. Utilization of systems that are user friendly.
4. The pursuit of vendors who offer the foremost solutions, not just a product for meeting a requirement.

I hope that this presentation has provided some incentive for your companies to review and upgrade your fall protection programs. In those instances where you are an owner or private enterprise letting out contracts for construction or reconstruction projects, remember third party liability by requiring a written fall protection program as part of the bid requirements, and a written plan to provide public protection from construction debris. Your efficient management of these projects shall promote safe and profitable work for your company.

I'd be happy to answer any questions and to go over some of this equipment I brought with me at break time. Thank you very much. (Applause)

Mr. Steele: Well, Pete tells me he's going to Alaska tomorrow and they have white bears there. I don't know if they're bigger than the brown bears or not, but hopefully he packed his tennis shoes. Pete also has some photographs of some safety nets that he installed. Feel free to talk to him about them.

Our next presentation is on the subject of different types of drip pans and alternative measures available. It is to be presented by Bob Kuhn with the Union Pacific. Bob and I have worked together for many years and I hold him in the highest esteem.

Bob received his B.S. degree in civil engineering from Iowa State University and his M.S. degree in civil engineering from the University of Southern California.

He has many held positions in his career, including structural engineer with Lockheed Aircraft Company, where he took part in the construction of the Lunar Landing Module and Ten Passenger Orbital Carrier, better known as the Space Shuttle. He has worked with the City of Los Angeles and the Smith Emery Company where he materials research and testing. Bob started with Union Pacific in 1977, holding positions of Assistant Design Engineer, System Bridge and Building Supervisor, Director of Environmental Engineering and presently is General Director of Environmental Operations. He is a member of this organization and the AREA.

With all of Bob's experience and teaching skills, he is instructing structural engineering classes at the University of Nebraska. Sit back and enjoy what he is about to present. (Applause)

DRIP COLLECTION SYSTEMS AT FUELING FACILITIES

Robert Kuhn

General Director Environmental Operations
Union Pacific Railroad

I am pleased to have this opportunity to meet with you and renew some old acquaintances. My affiliation with this group began in 1980 when I was a system B&B supervisor for Union Pacific.

In about 1984 I took a wrong turn and found myself in the environmental management business for Union Pacific. This has been very interesting work, and it is a challenge to say the least. I must admit, however, that I am so tired of being the bearer of bad news in a non-revenue producing capacity for the company, that I often long for a good bridge construction project to sink my teeth into.

I am sure you all are faced in one way or another with the same pressures in the environmental area as we are at Union Pacific. The railroad industry is going through a cultural change that gives a new meaning to lean and mean. At the same time, there are so many new laws in the environmental area that we are forced to spend literally tens of millions of dollars per year, more than was required by past standards.

At Union Pacific, our Environmental Management Group has grown from 12 of us in Engineering Services two years ago to 48 in a separate group under Risk Management today. Our budget has nearly tripled in the same period for environmental management, and the regulatory agencies appear dedicated to preserving the trend for a few more years. We have stepped into a time warp where new environmental laws focus our attention on oil spill prevention, stormwater management, underground storage tank management, air quality management, industrial wastewater management, hazardous waste management, and spill reporting and clean-up. The days are gone when "out of sight" was "out of mind". In fact if you saw it spill and you know it is soaking into the ground you better be doing something about it. The consequences of neglect are severe.

The economic penalties range from the loss of the material spilled plus nominal clean-up costs (if clean up is timely and the spill properly reported); up to tens or even hundreds of dollars per gallon clean-up cost plus penalties and fines of up to $25,000 for each day the spill was not reported or cleaned up.

The new aspect of all this in recent years is criminal penalties including jail time for company employees guilty of negligence. This prospect has shaken the boards of directors of most companies to act in a more proactive manner to support the environmental compliance efforts of their company's employees.

I am not here to suggest that diesel fuel spills are likely to put you in jail, but I am suggesting that willful neglect of environmental compliance, on your part or on the part of your supervisor or his superiors, could. The general understanding is that the highest ranking official of the company who was aware of the practice or occurrence, whether or not he knew it was illegal, is the one most likely to be prosecuted for criminal violation. You should contact your company law department or your personal attorney if you have detailed questions in this area.

My topic today is drip pans used to protect against petroleum drips and spills at fueling facilities and engine ready tracks.

Introduction

Drip pans are relatively impervious, curbed surfaces beneath fueling facilities or engine ready areas to catch dripped or spilled petroleum products from locomotives. Drip pans that are not under a roof generally collect storm water in quantities that require a water treatment plant (oil separator) and often a permitted wastewater discharge.

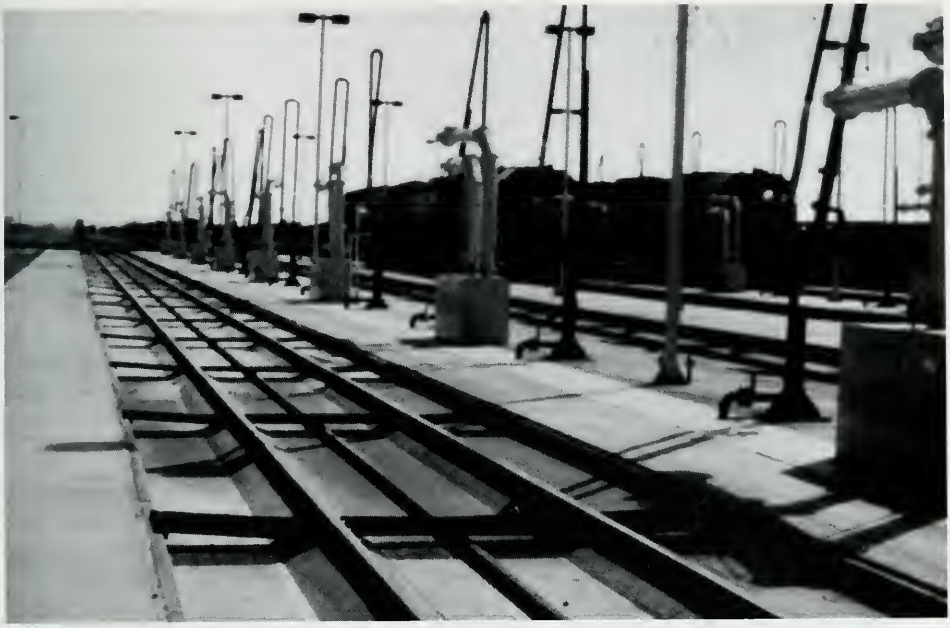
Most drip pans are made of sheet steel, concrete, or plastics (fiberglass). Except for poured-in-place, reinforced concrete, most drip pans are prefabricated units that rest on the cross ties (usually 15 feet long switch ties), with cross drains between the ties.

Drip pans cost about $300 per lineal foot to install, not including piping and water collection systems. Without drip pans, the alternatives are to prevent drips and spills, use absorbent pads to catch drips, or clean up the oily soil and ballast as required.

General Discussion

The comparison of types of drip pans does not present a clear preference. For initial installation, steel is generally most expensive and easier to adapt to curved track. Precast concrete is slightly less expensive, but not as easy to adapt to curved track. Plastic (fiberglass) is significantly less expensive to install.

The durability of steel is somewhat greater than concrete and much greater than fiberglass. The life span of each type depends on the way they are treated and maintained, but experience shows that concrete cracks and spills, plastic (fiberglass) cracks and breaks, and



Prefabricated steel drip collection pans with poured in place platform alongside.

Secondary membrane being installed beneath drip collection system.

steel bends and dents, particularly when maintenance-of-way equipment rolls over it. It is important to consider the patching and sealing of prefabricated drip pans.

Poured-in-place concrete or a combination of poured-in-place and prefabricated may be the ideal for those yard and terminal locations where track surfacing is not a frequent requirement. For main line fueling locations, the prefabricated units allow resurfacing of the track profile.

A below ground plastic liner can be installed to serve as a "double diaper" beneath fueling facilities. It is also important to have drip pans or a drip slab at truck or tank car fuel unloading areas. We have used all of the above types of protection over time on Union Pacific. It is a constant challenge to maintain and renew these facilities as the old ones wear out or fueling locations change.

Maintenance Requirements

Drip pans that are not under a roof must be designed to handle storm water as required for the area of installation. It is necessary to keep drains open and clear of sand and debris. This is a major design consideration. It is difficult to clean sand from drip pans completely covered with walkway grating. Many states will not permit stormwater to discharge to a publicly-owned treatment works (POTW). In this case, you must roof over the facility or apply for an NPDES discharge permit to discharge to the surface waters. Stormwater holding ponds are difficult to maintain oil free. Union Pacific has begun using closed steel tanks for all stormwater holding.

Drip pans must be patched or replaced as they crack or break up. Broken drip pans allow oily water to soak into soil under the drip pans and compromise the protection. Damaged panels of prefabricated units must be replaced to maintain integrity of protection. Neglect of maintenance creates oily soil around fueling facilities. It can be covered temporarily with clean material, but unless operating and maintenance practices are improved to avoid the spills, the oily conditions will return soon. This type of "treating the symptoms and not the problem" is very costly in the long run.

Where no discharge is permitted, holding tanks are required. Holding tanks for collection of drainage from drip pans must be pumped out at regular intervals to prevent overflow. Spill protection is required for used oil tanks or holding tanks. Where waste water from a drip pan system is discharge to either surface waters under NPDES permit or to a POTW, discharge monitoring (water testing) is generally required. This is to verify that the discharge is within acceptable limits of cleanliness. The NPDES permit generally has more strict limits and more regulated parameters to test for than does a permit to discharge to a POTW.

Alternatives to Drip Pans

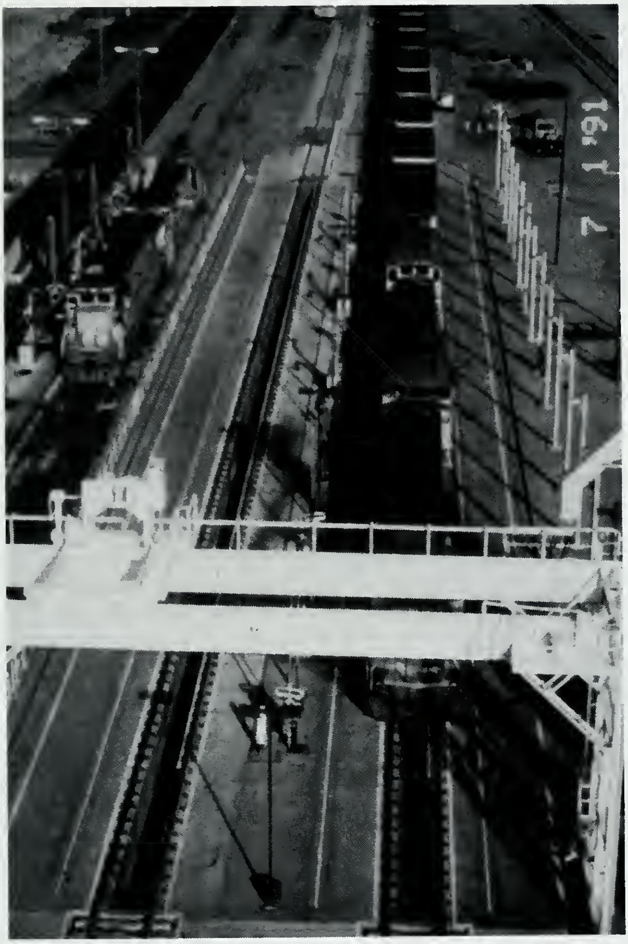
As stated earlier, the choices are to (1) avoid spilling, (2) catch the spills, or (3) clean up each spill that occurs. There are some alternatives to drip pans to catch spills.

For low volume drip areas such as engine ready tracks or low volume fueling locations, absorbent pads can be used to advantage. This alternative involves laying down pads to absorb spills and replacing the pads at periodic intervals as they become saturated.

Locomotive retention tanks to catch engine compartment drippage can be used to prevent drippage in engine ready areas and along the right-of-way. This requires a program to empty the retention tanks regularly. On Union Pacific we have a program to retrofit all our locomotives with retention tanks over the next several years.

There are a number of approaches to spill prevention. The first is close attention to detail by the fueling operator. Other methods include automatic shutoff on fuel nozzles, overflow return to fuel tank, and spill warning devices.

Certainly on very low volume fuel locations, and to a degree at all locations, spill or overflow clean up is an important matter. Regulatory authorities require reporting and clean up of all releases of 25 gallons or more in most states in which we operate.



Poured in place drip collection slabs at service tack & fueling.

Summary and Conclusions

There is no magic. You can avoid the spills or deal with them. Prudence dictates drip protection at major fueling and engine ready areas; there are alternatives for lesser areas. The cost of frequent clean up is prohibitive.

A carefully run fueling operation may spill one-fourth of one percent of the volume dispensed. That is 2,500 gallons per year at a 1.0 million gallon per year fueling location. If it costs $25 per gallon to clean that material up, the cost would average $62,000 per year. A spill protection system can be justified to avoid this cost. The payoff is even greater at higher volume facilities. The best choice is to avoid the spills, but experience has taught that spill protection is needed at all medium and high volume fueling locations.

Afterthought

Why don't airlines have a lot of fuel on the airport parking aprons?

Two-Part Answer

1. Their facilities are mostly underground.
2. They have an attendant paying close attention to the fueling.

Comment

Answer number two has some value for railroads to copy.

I want to leave you with my favorite environmental poem. It is called "Reincarnation".

"What does reincarnation mean," a cowpoke asked his friend. His friend replied, "It happens when your life has reached its end. They comb your hair and wash your neck and clean your fingernails and they lay you in a padded box away from life's travails. The box and you go in a hole that has been dug in the ground, and reincarnation starts in when you are planted beneath a mound. Them clods melt down just like your box and you, who is inside. And then you're just beginning on your transformation ride. In a while the grass will grow upon your rendered mound, until some day on your molded grave, a lonely flower is found. And say a horse should wander by and graze upon this flower that once was you but now has become vegetative power. The posy that the horse done ate up with his other feed, make some bone and fat and muscle, essential to the steed. But some is left that he can't use and so it passes through. And finally lays upon the ground, this thing that once was you. Then, say by chance, I wanders by, and sees this on the ground and I ponders and I wonders at this object that I found, I thinks of reincarnation of life and death and such, and I come away concluding, Slim, you ain't changed all that much." (Applause)

Mr. Steele: Thank you, Bob. I knew this would be an entertaining time.

Our last presentation today is rather interesting. It is about a flood on the Trinity River in Texas that washed out a center pier of a turn span and what was done to resolve the problem.

Giving this presentation are two gentlemen who took an active part in solving and repairing the problem. First we have Mike Bietzel with Modjeski and Masters Consulting Engineers. Mike has had 19 years experience in inspection, rehabilitation and construction of bridges. He attended the University of New Orleans for three years working towards his degree in civil Engineering. He is a certified senior engineer technician and is a member of this organization and The Steel Structures Painting Council.

Next we have Dewey Walls who is a B&B supervisor with the Southern Pacific Transportation Company with 18 years experience, 13 of which are in the bridge department. He has spent all of his railroad career in the southwestern United States. Gentlemen, tell us about saving the Trinity River bridge.

CHANGING I-BARS AT TRINITY RIVER

(Saving the Trinity River Bridge)

Dewey R. Walls, Southern Pacific Company
and
Michael J. Beitzel, Modjeski & Masters

Introduction

"Saving the Trinity River Bridge" is a rather pretentious sounding title for a presentation, but after you hear and see the particulars, I think you will agree on its appropriateness. In fact this bridge has been in imminent danger of collapse and saved twice during the past two years. The continued existence and use of the structure is due in large part to the alertness of the SP B&B crews who discovered and reported the problems, and by quick and decisive action by the Railroad and private engineering forces, who used rather drastic and unique techniques to restore the safe capacity of the bridge. Our presentation today will deal with the latest emergency repair.

This presentation describes the emergency repair of the bridge's swing span after the near catastrophic loss of its center pivot pier during the severe flooding of the Trinity River near Liberty, Texas, early in 1992.

The Southern Pacific's main line between Houston and New Orleans crosses the Trinity River at Mile Post 321.98 near Liberty, Texas. The Trinity River is the longest and deepest river totally within the state of Texas and has a watershed area larger than nine of the country's smallest states. Prolonged rains in the Dallas area during the end of December and early January caused extensive flooding which received national attention.

The Livingston Dam, some 75 miles upstream of the bridge, impounded large quantities of that flood water. To keep within an acceptable range of operation, the dam, which has no spillway and cannot be topped without catastrophic results, released 100,000 cubic feet of water into the river below the dam. At the bridge site normal flow is reported to be 7,000 cubic feet per second with normal flood conditions at 20,000 cubic feet per second. However, during the critical period of the flood, flow at the bridge site was at a sustained 100,000 cubic feet per second, with a velocity of approximately six feet per second.

The Trinity River's alignment with the bridge is poor, taking a right angle bend at the bridge. The water strikes the piers at various angles from head on at the east bank pier to 30 degrees at the channel piers. During the peak of the sustained flooding the water was within 14 inches of the low steel completely covering the tops of the piers. It was predicted that the river would remain at or near that level for several weeks. As it turned out the river remained at or above flood stage for more than several months.

The Trinity River Bridge is a single track thru truss bridge built in 1919 and consists of a 225 feet pin connected simple span and a 225 feet swing span to the west flanked by timber approach trestles. Pier undermining in the 1940s was stopped by building sheet pile cells around the pivot pier and east rest pier and backfilling with sand and capping with concrete.

I'll now turn the podium over to my partner, Dewey Walls, B&B Supervisor for the Tucson District for the Southern Pacific Railroad, with whom I spent the cold, wet dog days of January in Liberty, Texas. He will recount the discovery and subsequent actions taken by the railroad during the crisis.

Mr. Walls: Thank you, Mike. As Don has said, I have spent a few years in Houston, but I spent the last three years in Tucson, where we might get 15 inches of rain all year long.

Discovery of Problem

On December 23, 1991, Bridge and Building Gang Number 4 out of Beaumont, Texas, was assigned to the bridge over the Trinity River at Liberty, Texas, to monitor the height of the water and to remove any debris that had flowed against the piers. The height of the water at the time was estimated to be around 42 inches from the bottom of the lower chord to the water level.

On December 30, 1991, the water height rose about 30 inches. At that time the gang went to two 12-hour shifts, inspecting the bridge after each train movement.

On December 31, 1991, around 10:00 p.m. after a westbound train passed over the bridge, the Bridge Gang went out to inspect the bridge for debris. The water height was found to be about 14 inches from the bottom of the lower chord. At about 10:30 p.m. the gang heard a rumbling and clinking sound coming from the bridge. They started inspecting the bridge and found the sound was coming from the center pivot pier of the 225 feet turn span. The bridge foreman, Joe Rodriguez, without haste called the train dispatcher at Houston, Texas, to tell him to stop all trains approaching the bridge until the gang had time to inspect the pier more closely. The gang saw the bridge seats move downstream and disappear.

Foreman Rodriguez called his bridge supervisor, Floyd Saltzman, in LaFayette, Louisiana, at approximately 10:40 p.m., to tell him the bad news that the center pivot pier had washed away. Neither Rodriguez nor Saltzman could believe this had actually happened. Mr. Rodriguez told Mr. Saltzman that he wanted to go back out to the bridge and reinspect the pier before he called anyone else to let them known what had happened.

Mr. Saltzman received another call from Mr. Rodriguez around 11:00 p.m., at which time Mr. Rodriguez reinforced his statement about the pier washing away. Mr. Saltzman then proceeded to contact Mr. Wammel, the bridge engineer in San Francisco, and told him the disturbing news.

The next day, January 1, 1992, Mr. Wammel received word that a 240 foot bridge in Bakersfield, California, had burnt down. So the decision had to be made by Mr. Wammel whether to go to Liberty, Texas, or to stay and take care of the bridge fire. At that point, he chose to go to Liberty, Texas.

On January 2, 1992, Mr. Wammel, along with Don Sorgenfrei of Modjeski and Masters, arrived at the site to assess the situation. To determine the extent of the pier loss, they secured the services of Whimpol Inc., of Houston, Texas, to provide side-scan sonar services. This same company was used the year before to determine the extent of damage to the rest pier, which at that time was sinking due to scour.

A hi-rail inspection truck equipped with a 20 foot pipe modified to hold the scanner was lowered into the water about 15 to 18 feet deep. The scan showed that the center pivot pier had been washed away from about 17 feet below the bottom of the lower chord. Only a small part of the pier remained at the south east corner.

A decision had to be made whether to wait till the water receded and reconstruct a new pier or try to strengthen the existing turn span immediately to restore live load capacity. The option of waiting till the water receded was controlled by a dam at Livingston about 75 miles upstream. It was predicted that it could be three months before normal flow would resume. The authorities at the dam indicated that with it being the winter season they had no idea when the discharge could be reduced.

The only reasonable alternative, given this information, was to strengthen the existing truss. Modjeski and Masters recommended and was given the task of coming up with a design to strengthen the truss without increasing the dead load beyond the capacity of the substructure.

The time frame in which the work was to be completed was a crucial element of the

project, with direct costs for detouring trains over other railroads being significant. The SP B&B Department did not have enough qualified welders, or available riggers and fitters to complete the project in a timely manner. The decision was made to contract the installation of the strengthening members to an outside contractor.

The outside contractor selected was H. B. Zachery Company of Houston, Texas. Their proposal called for 24-hour shifts, completing the work in 18 days, utilizing the following manpower and equipment:

Manpower per shift:

4 Support Staff
1 Foreman
12 Welders
6 Fitters
4 Riggers
4 Helpers

The major equipment proposed for use were:

16 – 400 amp welding machines
16 – wire feed flux cord welding machines
4 – 4000 pound Air Tuggers
1 – 60 air compressor
Consumable gases and electrodes
Miscellaneous hand tools.

The railroad would supply the required steel sections, support equipment, manpower and general lighting.

The following railroad equipment was used:

50-ton Ohio Crane
60-ton American Crane
1 Jackson Bridge Crane

Preliminary work by the railroad included the set-up of the cook trailer and tent, walkway decking with plywood, refuge platform construction, construction of an access road, and grading and filling for a parking lot and fabrication yard.

The railroad provided for daily handling and ordering of material. Three hot meals were served daily which were well appreciated and provided for all workers.

I'll turn it back over to Mike.

Mr. Beitzel: Thank, you, Dewey.

The Repair Plan

The swing span no longer had a center pivot pier and was sagging approximately one and a half inches at midspan. The bridge no longer had the capacity to support the load of a pile driver to re-establish a center pier. The river current was too swift and there was no access to launch a floating pile driving rig. Side-scan sonar indicated there was little left of the original pier. Due to these constraints and the projected continued high water, it was decided that strengthening of the swing span to convert the bridge to a simple span, if feasible, was the proper course of action to take for the short term. Design and detail sketches to determine the feasibility of such a plan were started on Friday, January 3, and a workable preliminary detailed plan was completed on Monday, January 6. Bids were taken to perform the work on January 10 and work was started on the January 13.

While adding weight to an already burdened bridge might not seem like the most rational thing to do, we were confident that with the proper sequencing it could be safely accomplished. Even with this confidence, though, we did maintain 24-hour survey monitoring of the span behavior.

To speed the repair, it was decided that all strengthening should utilize welded details. Strengthening beams were required on the top and underside of both the upper and lower chords. Additionally, diagonal members L2 to U3 and the end portal gusset connections required strengthening. Finally, the expansion bearings at the west rest pier had to be converted to fixed bearing.

The first order of business was to increase the tensile capacity of the bridge lower chord, particularly at midspan. A W14x233 was selected for strengthening of the lower chord and was to be placed in three segments joined together by full penetration butt welds on the underside of the chord. The flanges of this section are wider than the lower chord and could easily be attached with 5/16 inch fillet welds. Intermittent fillet welds six inches long at two foot centers were utilized on all but a 10 foot length of continuous fillet weld centered on each panel point.

To receive the strengthening member, the lower chord bottom lacing was removed as well as a portion of the bottom lateral connection plates. The remaining portion of the lateral connection plates were welded to the flange of the strengthening beam when it was installed.

Sequencing was critical at this juncture. A 60-foot length of beam was first installed centered at midspan of the south truss. Only after all continuous welds were made and after all lateral plates were reconnected could work begin on the north truss. With the two center sections of strengthening beam in place, the end 55 foot sections at opposite ends and on opposite trusses were worked simultaneously. With all beam segments in place the full penetration butt splice welds were made. Each splice weld required approximately 24 hours to complete with two men welding at each splice due to the thickness of the flanges. It was crucial that preheat and interpass temperature were maintained during the entire process and that welding be non-stop. Once completed the welds were wrapped with ceramic blankets to control the rate of cooling to prevent embrittlement. The welds were then examined by ultrasonic testing and passed prior to continuing the remaining work.

With the underside beams in place and the lower chord tensile capacity restored, the top side strengthening of the lower chord was installed. This much lighter W12x87 was required to control bending moment due to the eccentricity of the lower chord by the addition of the underside beam.

The W12x87 beams were installed after removing the chord lacing bars with the edges of the flanges resting on the lower chord channel flanges and fillet welded. Each beam was cut to length to fit between adjacent panel point gussets and the beam ends were fitted with fill plates to accommodate the varying widths between gussets and were welded to the gusset edge. Again the beams were installed by working out from midspan of the bridge with the restriction that no two consecutive panels have all lacing bars removed. A railroad tiehandler was light enough to be used to place these beams in position on the span.

Calculations indicated that there was some reserve capacity in the bridge upper chord under dead load only. It was beneficial that all additional weight was to be added prior to installing the upper chord strengthening. Diagonal members L2 to U3 and the corresponding diagonal at L2 to U3 were strengthened next. The diagonals were box members composed of two laced channels. A half inch plate was fillet welded to the outstanding edges of the outboard channel flange. The diagonal member connection also required strengthening and rather than add additional bolts to the connection the capacity was increased simply by adding 12 inches of fillet weld between the channels and the gusset plates. This same technique was used to strengthen the member connections at the upper and lower end portal connections.

Top chord strengthening was accomplished simply by laying a W14xl2O on its side on top of the upper chord cover plate and fillet welding along the flange edge. The hardest part about this operation was getting the members to the center of the bridge. The members were dragged across the top laterals with winches mounted on the top chord. Member splices were made with full penetration single bevel butt welds.

The installation of the upper beam provided for the increased compressive strength required. However, again due to the eccentricity, underside strengthening to resist the resulting bending moment was necessary. The design for placement of the underside strengthening required continuity of the beams across the gusset plate connections, and, unlike the lower chords, they could not be terminated at the gusset plate edges. A W24xl04 was required and, as originally planned, the members were to be laid on the sides split to proper width to match the out to out dimension of the upper chord channel lower flange edges and rewelded. Additionally they were to be forked at the ends to swallow and cross the exterior of the gussets and the ends butt welded together at each panel point. Along the length of the chord the beam was to be fillet welded to the outstanding channel flange edge. Field modifications of these details were undertaken to speed the installation. The splitting of the beams was avoided by installing fill plates, where necessary, and by spreading or closing the beam flanges into contact with the chord channel flanges not to exceed 1/4 inch. Rather than forking the beam ends these extensions were cut and spliced in separately.

All that remained was to convert the rocker expansion bearing to a fixed bearing at the west end of the span. This was accomplished by welding wedges between the base plate and the underside of the rocker.

Prior to opening the span for rail traffic a test train was run across the bridge. The test train was composed of three locomotives and eleven ballast cars weighing approximately 265,000 pounds each. Survey instruments, both optical and laser, monitored the deflection of the span as the ballast cars were backed onto the bridge. Span behavior was as expected and all tension welds were checked by the magnetic particle method with no flaws detected. The engines and cars then crossed the bridge at five miles per hour and 10 miles per hour, again span behavior was as expected and all welds were rechecked with no flaws found and the bridge was opened for traffic with a five miles per hour slow order.

Welding Requirements and Procedures

All the details discussed employed welded connections. The contract specifications required the use of the relatively new Bridge Welding Code AWS Dl.5 - 88. Which essentially has combined the old AWS Dl.1 and AASHTO welding provisions with some modifications. The provisions of Dl.5 give clear and decisive standards to eliminate the chances of weld cracking. Fortunately, we have on our staff a certified welding inspector, Steve Snyder, who was brought in on the project to oversee the welding aspect of the project and in essence to train the contractors quality control on the provisions of this code with which they were unfamiliar.

Our primary concern was to make quality welds on the first attempt in order to prevent delays for weld repairs. As you have heard, several of the welds took considerable time. In this regard, all welders on the project were required to have recent and proper certification. In fact, site certification testing was set up due to a lack of qualified welders meeting the requirements of the bridge welding code. A log was kept on the location and type of every weld made and the welder performing the work. Additionally, each welder was required to initial each weld he made. In this way, welders making recurring poor or deficient welds could be readily identified.

Shielded metal arc welding, using E7018 low hydrogen electrodes, was the method of welding utilized. It was originally intended that flux cord arc welding be used. In fact 12 new FCAW machines were purchased by the contractor for the job. However, due to the windy conditions on the bridge, shielding gases were blown away causing porosity in the welds. A larger wire size may have solved this problem but the machines purchased would not handle the larger wire and did not have separate voltage and wire feed speed controls. Additionally the FCAW procedure would have to be qualified and all welders certified for the procedure. Procedure qualification is not required by the AWS Code for Shielded Metal Arc Welding producing weld metal under 90 ksi.

A major concern in producing quality welds was maintaining the proper preheat and interpass temperature of 150 degrees and proper storage of electrodes. A man was assigned to each welder to provide constant proper preheating that was checked with temperature indicating markers. Each welder was also provided with a rod oven for storage of the electrodes to prevent moisture contamination of the electrodes which could cause hydrogen entrapment in the welds and possible cracking.

To reduce welding time, all fits and tolerances were kept to the minimum allowable. Bevel angles and root openings were kept to a minimum in all full penetration welds. Back up bars were used to eliminate the need for back gouging.

All welds received 100 percent visual inspection by both the contractor's quality control personnel and our certified welding inspector. Magnetic Particle testing was conducted by an independent testing lab using a Certified ASNT Level III inspector on all tension member fillet and groove welds, and Ultrasonic testing was used on the tension member full penetration weld splices.

Conclusion and Current Status

The following things were done and should be done in these emergency repair situations, especially with a contractor providing the labor:

Early on in the project, the principals of the companies involved should conduct a site meeting with the project staff to clearly define the duties, responsibilities, authority, and expectations of all parties involved. This proved invaluable in avoiding confusion, miscommunication and delays.

Careful attention by either a B&B foreman and or a consultant to the details, anticipation of problems, field modification of plans and adjustments to sequencing is required and a time saver.

Think ahead of the contractor to anticipate problems and have workable solutions before it is time to perform the work.

Make good unhindered use of the expertise, judgment and talents of all the people involved, and keep all parties informed.

The use of proper tools and the latest equipment such as die grinders to clean welds, side-scan sonar to determine the extent of pier loss and laser survey instruments for monitoring span behavior proved invaluable.

The creative use of equipment can speed construction; in this case, for example, using a tie handler to set the strengthening beams in place.

Go the extra mile to provide creature comforts such as in this case, providing hot meals to the workers. This saved time and boosted morale and productivity on the cold wet days and nights.

Mr. Walls: In conclusion, the Trinity River Bridge was by necessity converted from a swing span to a 225 foot long simple span in 18 days. This was made possible by the collective efforts and expertise of all parties involved - the railroad, the contractor, and the consultant. The bridge was returned to service on January 31, 1992, and follow-up inspections of the strengthening and welds have been performed and no problems have been observed.

The scour problem at the bridge remains due to the alignment of the river; our efforts in January to keep the bridge operable were only temporary. A replacement pier is currently being installed to replace the lost pivot pier to effect a more permanent repair. The new pier is constructed of four concrete filled 36 inch steel pipe piles outside each of the existing trusses connected by a transverse steel box beam which will be put in light contact with the underside of the bridge.

Thank you for your attention. That's all I have. I'll entertain questions if anyone has any.

Member: What was the cost of all this?

Mr. Walls: $460,000.

Member: How did you determine the rest of the pier could take the additional loading?

Mr. Walls: The two rest piers? Yes. We had plans for those and we had calculated those when we did the salvaging of the east rest pier.

Member: Did you have any injuries on this job?

Mr. Walls: There was one minor injury. The iron worker foreman had a small beam, I don't recall what he was using it for, but a group of them were moving it by hand, as everything was being moved. It caught his glove or his glove fingering and smashed it between that and a top cord.

Mr. Walls: Thank you very much. (Applause)

President Walbrun: As information, there are copies of the Bridge and Building special reports at the table in the back of the room. Also, please fill out one of the special subject cards for 1993. The input for this will be used for the special subjects that we will present at the 1993 conference in Denver.

We have reached the point where if there are no more special announcements or questions we will adjourn. Be sure to meet with your friends this evening at the reception sponsored by REMSA in the Wellington Ballroom at 6:15 p.m. This meeting is adjourned until the joint session tomorrow morning at 8:30.

Session adjourned.

WEDNESDAY JOINT SESSION

September 23, 1992

President Hill: Ladies and gentlemen. We will now call this final joint session to order. Our thanks to REMSA for the wonderful reception last night. We always appreciate their fine hospitality.

As of 8: 30 this meeting our registration stood as follows: 76 B&B, 146 Roadmasters, 268 Suppliers, 115 Guests, 98 Spouses, for a total of 703.

Ray Brosseau will introduce our first special feature this morning.

Mr. Brosseau: Thank you, Steve. Our next presentation is about commuter rail in Los Angeles and will be given by John Rinard, Director of Engineering and Construction for the Southern California Regional Rail Authority. Prior to his present position, John was chief engineer for the Los Angeles County Transportation Commission and an assistant division engineer for the Southern Pacific Transportation Company. John is a graduate of the University of Utah and a licensed professional engineer for the state of California. John is a member of the Roadmasters and Maintenance of Way Association and the AREA.

COMMUTER RAIL IN LOS ANGELES

John Rinard

Director of Engineering and Construction
Southern California Regional Rail Authority

Thank you and good morning. We had an update at the AREA fall conference last year and the biggest question I put out to the group was I didn't know if we would get the system in Los Angeles up and running. The biggest question was selecting a color and naming this service. So I'm here to report that those two things have been completed. Only in California would they pick the colors of periwinkle blue and teal. The name of the service is Metrolink, linking the outer neighborhood areas to the inner Los Angeles business areas.

In addition to picking the colors and naming the system, we have completed and will soon put into service 50 miles of new track and wayside signal construction, 58 grade crossing renewals, seven bridges, one interstate overpass widening, a 3,000 foot long viaduct which goes up and over the Southern Pacific freight main between Los Angeles and Chicago, two layover facilities for night layover, a central maintenance facility that will service all the locomotive and rolling stock and a central dispatch facility that was in service last week.

To date, we have laid 12,000 tons of new rail, 1,500 tons of relay rail, 55,000 concrete ties and 155,000 timber ties. The biggest question in California was how to fund such a commuter rail system. Freeway speeds are down into the teens on the miles per hour right now during average rush hour and it's been steadily decreasing over the last decade and half. The citizens finally voted in a sales tax in just about all of the counties to fund future rail projects. The freeways are always clogged with traffic and the price of homes has forced the typical new family to move in excess of 50 miles from the Los Angeles area and then fight that commute traffic to and from work.

The strong opposition to freeways came through the air quality side of things as well as we have freeways from wall-to-wall on either side. Air quality is an extreme problem in the southern California area and getting worse. In the ten year census and in the statistics we have compiled, the population in California has increased 25 percent over that ten year period. Licensed drivers are up 35 percent and registered automobiles have increased 40 percent over the same period. While vehicle mile travel increased 60 percent, new road construction only increased two percent.

You can see the dilemma which is facing the California people. California is now faced with double decking the freeways. The cost of this is astronomical so they've opted for the alternative, mass transit.

The clean air requirements have been the major push in this. The South Coast Air Quality Management District has established some goals that will impact everybody in the California area over the next several years. By 1994, each company that employs over 100 people will have to have 1.26 riders per car ratio. That doesn't sound like a lot but it's already becoming stressful for those employers who are planning for that. That will increase to 1.5 in 1997 and 2.1 in the year 2010. In 1994 they have to eliminate the cold start in cars when you crank them up in the morning. In 1995 the new buses must burn clean fuels. In the year 2000, 70 percent of fleet vehicles must burn clean fuel and in 2010, 45 percent less air pollution from motor vehicles.

How do you put something like that together? In California, typically, the counties didn't talk to each other. In fact they fought with one another over the past about funding freeways, tollways, carpool lanes, any number of projects. In 1989, the state of California, through a senator from Riverside County, passed State Bill 1402 which required a regional system of management for commuter rail funds. With that, five counties (Los Angeles, Orange, Riverside, San Bernadino and Ventura) came together and formed the Southern California Regional Rail Authority.

The biggest success to date of getting the first phase of this up and running is the commitment of the county politicians to support the management and the staff to implement the first phase of this work and we have seen amazing support from them. The funding is coming primarily from sales tax. All the counties except one have taxed themselves with a minimum of one-half cent sales tax and three of them have taxed themselves a full one percent of the sales tax in the local funds. The state has contributed in matching money, 21 percent through the gas tax and 20 percent from the federal gas tax revenues.

The system is 150 miles left to right and 150 miles top to bottom. So it's not a very big railroad. The interesting thing about it is that it goes through Los Angeles and there are 16 million people who live and work within this Los Angeles basin which is surrounded by mountain ranges on all sides and the ocean to the west and south. The growth has been astronomical and it has affected the business industry in this valley. The system is made up of agreements, primarily with three different railroads; the Santa Fe, Union Pacific, and Southern Pacific. We opted to work on a win-win situation with the railroads where the railroads looked at line signalization, bottom line costs, what are the true needs they have to run the railroads with and of course, liabilities. Then with our win situation we were looking for right-of-ways to start running passenger trains on. It originally began that we would buy outright right-of-ways and then run only passenger trains. Then any of those lines that were only local freight would run at night or midday hours only and we would pretty well run separate other than times of day. As that matured since the early part of 1990, we have now entered into shared use agreements and trackage rights agreements. Basically, it's been a win-win situation. So far it's worked out, we think, remarkably well. We haven't run any revenue trains, but in 33 days, we will begin the first segment of that service.

Startup costs that we've spent by October are estimated at $370 million. The average cost of that for the 300 mile system would be a $1.25 million per mile. That ranges from right-of-ways which had a 100 percent rebuild, where we completly eliminated the old track, some of which was built in 1887, to some of the newer tracks where some of the main line didn't have to be touched. But we would add an additional siding or two or some slight upgrades, possibly signalization improvements, so it was a mixed bag of what developed over time. Prices are still pretty cheap.

The Ventura county to Los Angeles line which is Southern Pacific's coast main line running between San Francisco and the bay area down to Los Angeles, is an example of a shared use agreement. The rail authority, through the counties, purchased approximately one-half of the right-of-way from the Southern Pacific. We then had the option to build our own system on that or to establish a shared use agreement, which we did. Then with that, we negotiated major terms of capital improvement. In this particular case, we built ten miles of new double track, layover facilities at the end of the line, some siding upgrades and Southern Pacific did the signalization work improvements on this whole line. It will be operational next month. We anticipate 3,500 riders per day. That happens to be the number of seats on the train. It will be interesting to see how many more studies we pay for to determine how many riders we have and secondly, what truly is the count. It will be interesting to see what the conversion from cars to train traffic is. Probably the biggest challenge has been working with a freight railroad that has been accustomed to their own operation. On the purchase agreement, the lead in requirement was that we work together to run an effective and sufficient on-time commuter system. So that has been a challenge. So far, we see great milestones in reaching that goal.

The Authority, with contractor forces, built the second main alongside Southern Pacific's existing main. We also did the bridgework along the same corridor. There are several underpasses of local highways and streets crossing over freeways. So, working immediately adjacent to Southern Pacific structures, we went in with our own designs and contractor forces and built parallel structures.

This is Santa Carrita to Los Angeles, which is the regional Bay area to L.A. alignment that the Southern Pacific built back in the early 1900s. The upper end of the line now has a new route that was built through the Cone Pass called the Colten Cutoff. This line gave us an opportunity to reach to the outlying bedroom communities and transport these people to the Los Angeles business districts. The line was purchased the same way, approximately one-half of the right of way, and then we established the same share use agreement on this line. There is less freight traffic on this, so we opted to only construct, with Southern Pacific's agreement, one new passing siding. We did rehab ten miles with new rails and ties to raise speeds to the 79 mile an hour operation and build it into line layover facility at the end of the line. This line is approximately 30 miles in length. Again, on that line, we built parallel to the SP structures. Close coordination with the authorities was a real challenge.

The most attention-getting line to open next month will be the Los Angeles to San Bernadino. The line was originally established to be a combination of Southern Pacific rights-of-way with Santa Fe rights-of-way. We've been negotiating with the Santa Fe for the last three years, so we've had to change our plans to accommodate the October opening. The line out to the Pomona-Claremont area will open in October, estimated 4,500 riders per day. That is a combination of Southern Pacific's State Street line which went down the middle of Interstate 10 and Baldwin Park line which used to be a California red car line back in the 1940's and 1950's which had been used for just local freight only. It was as narrow as 33 feet in sections where we were requested to put main end siding through 33 feet corridors and probably the single largest challenge we've done on this particular line.

The stations have been a challenge because there was a lack of property to put stations on and difficulty working with the cities, getting them to respond in the time frame needed. We can probably get the track working and trains running, but if we can't get the people to them, it doesn't do us much good. We have concluded the Santa Fe agreement that will purchase an additional 340 miles from the Santa Fe which will then give us this link to San Bernadino on the right end of the line for an additional 30 miles. This will probably go into service early next year. On this same line at City El Monte, where we come out of the Southern Pacific State Street line and go into the narrower Baldwin Park, we cross up and over the Southern Pacific's main line between the ports of L.A. and Chicago and other points east. The requirement here was to grade separate that and we didn't believe we would get it built. The structure is a 900 foot bridge with a 1,500 foot approach on each end. It has freight clearance standards for doublestacks and quite a challenge. It goes through the city of El Monte, has a couple of undercrossings over a major river, a flood control channel, and the Southern Pacific itself. It will be opened October 26th. In fact, we're putting tracks on the structure beginning Saturday.

In the narrow Baldwin Park section the contractor suggested concrete ties with McKay clips, pretty much the BN and UP standard on this particular tie. We did go for that because of the out-of-phase construction for some 20 miles. So this is the one case where we have concrete ties. It's 136 pound rail so it ought to last quite a while. This line will probably only run about 12 million gross tons a year, which will primarily be commuter trains. We have local freight out here which is not extensive. The corridor is narrow, and there is close proximity to the industries and homes along this line. There are 32 crossings in a 16-mile stretch.

The fourth line which will come to service early in 1993, is a new Union Pacific shared use agreement. In this particular case we bought some property along the Union Station area of Los Angeles, then we bought trackage rights 55 miles out to Riverside County on the Union Pacific. This line has the potential of being the fastest commuter line in that it is restricted to five stations maximum on the line and each station is required to have passing track, or double track, so it should be very fast. We are working with Union Pacific now to increase the speed to 79 miles per hour for commuter trains. We will be running in the 70s when we start that train. The question is, is it worthwhile for the extra nine miles an hour if you can't accelerate and reach it. This was a last minute line that came in, which deals with the politics in the area and also the demands. It was an idea that was thought of late and was consummated over a 60-day period with Union Pacific. The Union Pacific has been proactive with us in commuter rail starts and are now completing their part of $36 million in improvements and new construction work on this line. A typical area that we're dealing with is congested, goes over structures, under crossings, over rivers and flood control channels. We are operating on a lot of secondary branch lines that we've purchased that have to be rehabilitated extensively. It's a very busy area. That's probably been our single biggest challenge, the many authorities we have to work with, be it city, county, flood control, Corps of Engineers or whoever.

We hope to start the first Santa Fe lines operating as early as December, 1993. The Santa Fe has just begun acquiring materials to begin this work. Dutch Lake is planning on laying rail in January; a monstrous effort on the Santa Fe's part to get this up and running. The line will reach from Riverside into Orange County and back up into Los Angeles and has the potential of two different commuter systems which run down into the Orange County/Anaheim/Disneyland area as well as the Los Angeles area so we'll probably feed two central business districts. The Santa Fe's main line is quite busy, with a lot of west coast Amtrak trains on this line as well. We have a plan to completely double-track this line with the Santa Fe and build out plans to go to triple tracks on this line as the traffic and needs grow. The southern extension of that same line will be purchased by the authorities in the counties which run from Orange County down into the San Diego County limits to the south.

In early 1993 we will begin construction of major portions of double track which will include several major bridges underneath that and then upgrades in the signal system, eliminating the pole lines, improving the on-time performance and keeping the system up, and keeping freight on this as well. This is the Santa Fe's link between the harbor of San Diego, up into and connecting to their main line for east-west traffic.

This originally was a three-phase project, but has been changed now with the completed Santa Fe agreements and the additional contract with Union Pacific. I had reported earlier a 300-track mile system, which is now approximately 450 miles with the new agreements. Of that, 150 miles will be pretty much a freight-only for the first several years, and then a smaller portion, 50-75 miles will be freight-only forever. We would maintain the tracks for the freight use and not run passenger trains over that. We see the railroads opting for that kind of changeover. I like to maintain some freight track, keep one foot on that field, but it was an opportune time for the railroads to consider what they wanted to do in their long-term strategic planning. So, we believe it was still a win-win situation. We bankrolled these abilities to run commuter trains on these lines and we'll look at the future envisioned needs to determine what we would with them for extended services.

What did we do to get it up and running? Amtrak was the successful proposer as the contract operator. They have crews learning the territories and the new equipment. We've tried to make that transition easy. We've tried to make Amtrak responsible for running the trains, servicing of cars and locomotives, as well as spot maintenance of the tracks, and keeping speeds up. Contract services is how we've done all of that, whether it be the design work, construction work, operations, liability or overhead costs.

Probably our staff's main learning curve is how to step out of the private industry that we've all dealt with into this public agency. We wish we had the benefits of both. How do you merge that without getting bogged down in the bureaucratic red tape, and yet live up to the fact that you're spending the taxpayers' money and there are accountabilities that you have to follow. It's not as simple as we thought, leaving the railroad industry and stepping over. It was a great learning curve for all of us. To date, we've pulled it off. We found out we can streamline the public process as well as try to rethink what they're doing and try to make it a little bit more private oriented.

Amtrak is responsible for the spot maintenance. They will not be responsible for rehab, capital or program work. We will contract that out, whether it be rail grinding, relaying rail, tie programs, crossing upgrades, any of those type of things. We will perform that through contracts as well as have additional assistance in case of emergency. In this particular case, we could have Amtrak forces and contract forces on the same derailment, if such a thing were to happen, working side-by-side.

We started out by making the stations the responsibility of the local authorities, whether it be a city or a county. We did that for several reasons, the strongest being that our plate was going to be too full to deal with individual stations, with all of the architectural demands that the local people and other interested groups wanted. We could also keep blinders on with getting the track and facilities up and running. We have three stations that will open next month. They responded well although they responded slow, and as of last week we have the first three stations with asphalt parking lots that are going to be ready for service. Between now and next month the balance of 13 stations will be in service.

In the future, we will probably work more closely with them and designate additional staff to handle the learning curve with those groups. We found that the authorities, and/or their consultants, really didn't understand what it meant to work inside a freight environment. They didn't understand clearances and strengths and operational needs. Colors, lights, all of those things was a tremendous review process that we had to do at the eleventh hour. So, in this case, we're going proactive out into the communities with standard plans for stations; what to checklist, what to watch out for and hopefully, with that, we'll not only decrease the cost, but improve communications with them.

In the future, we hope to go with procurement contracts, whereas now, we've basically bought ourselves a Chevy or Ford and we would like to be able to buy parts for those. I find it a little more difficult on the public side to be able to acquire what you need with the competitive bidding process, so we are progressively working to put procurement contracts in place so that we can buy the materials that we need to resupply ourselves over time. We're speaking to many of the suppliers now to develop that.

Finally on this list is common standards. We are developing our own common standards, not reinventing the wheel, but basically things that we can work with in the future with a little bit more common sense.

The operator, Amtrak, has a limited three-year contract with us to operate these trains and through this contract, they're requested to be separate and distinct from all the other services they have around the nation. So that will be the biggest challenge for Amtrak, as well as our staff, to manage that and keep that functioning. The demands that the regional rail authority requested in the Amtrak contract were, I think, greater than what we had envisioned on typical commuter operations around North America. That will be interesting to see how it works over time. One of key things we did to live up to the time frame of opening was to marry design and construction management teams into one. In addition to that I placed a project manager from our staff into the field on each one of those construction packages and then that manager was responsible for the day-to-day problems. The original construction contracts that we put out married track, bridges and signals together. We took quite a gamble with that, but because of the time frame we needed to get a very responsible prime contractor to take the lead and then place large requirements on his subs to live up to the sub categories' responsibility. The central control facility was also put in the original track package, only because of time, and to date we can report that was the way to go. I don't really know what premium was paid for that, but we're quite excited with the response from the contractor world to deliver that. So, to date, it's been successful.

All of the trains will be maintained in a midday service in Los Angeles, return in the afternoon to the outlying layover points where there will just be minor cleaning and emergency-type maintenance. They will layover overnight and then do return trips in the morning. That's pretty much the start-up plan. The maintenance facility shop in Los Angeles is patterned after the Toronto, Canada, GO facility, with a slight reduction in size. Overall, it's the very same concept where the Amtrak train unit pulls into the progressive shop, the locomotive or cars are inspected and maintained and it's run out the other end and back into service with a minimum of downtime. The trains then run in unit consist and then broken up. The maintenance facility has an overlap with startup. The coach shop, yard and service islands and the sanding towers are completed. We will turn several milestones between now and the first of the year. It's been a remarkable effort by the contractors and the Southern Pacific working closely with us.

We tried to keep the stations generic to keep the clearances, the visual, the safety things that we accept as normal on the railroad and to build in needs we may have over time. We put out concept plans to the cities and have worked pretty closely with them, but it was a much greater problem than we had anticipated. We're working to improve that. Parking is going to be a problem, so we have enacted a much larger bus interface program. The first three lines will proceed into Union Station in Los Angeles which basically revitalizes train traffic in a large way, although Amtrak does run intercity service and a smaller San Diego-L.A. service into this facility. We have put $18 million of improvements into this facility to handle the commuter train operation. The handicapped status under the Americans with Disabilities Act has required us to use eight-inch high platforms over top of rail. We also have mini-platforms on the islands for unloading wheelchairs and disabled riders.

The new Los Angeles subway goes underneath Union Station, directly underneath the track section. So we have coordinated closely with the subway personnel to allow our people to go straight into the subway to be dispersed around Los Angeles. That will not begin service until March, therefore, there will be five months of a lot of buses running.

Procurement in the future, primarily rail, tie and ballast, turnouts and OTM. Signage has been a problem because there are so many authorities involved in the program. We've had to standardize. We're working on standard sign packages now for the rights-of-way, much like we did on the railroad, but with the time crunch, we were not able to get those standards out and in the hands of everybody and so we're playing a little bit of catch up with that.

Grade crossing panels, typically, our system has been concrete. We've worked with some of that. We've got some test cases in. We've put in the new Omni rubber insert that has rubber on either side of the rail with the concrete panels on the field and gate side of those. It went in very well, now let's see how it lasts. It sure looks good. Spot maintenance is being done by the operator, the rest of it being done through contract, which we are acquiring this week and hope to be wrapping up in the next 30 days. Included with that is the fiber optics backbone system that we will use for backup system to the signals as well as links to the PA, CCTV, ticket vending machine, polling at each of the stations.

Common standards is basically a marrying of the SP, the UP and the Santa Fe and the AREA standards into Metrolink's. Again, not trying to reinvent the wheel, but stick with proven products and materials and going forward with that. The contractors worked with us. In their contract, we required them to provide personnel who are competent in the fields with which we were asking them to work within. They tended to go all out and hire either former or current railroad employees and mesh them into their construction world. And they were then the ones who really made it work.

This yard is pretty much finished. The contractor in this case had to work with us and the community rather closely since we're surrounded by homes on all sides and the railroad parallels the Los Angeles River. We had to work very closely with the local people in this case. We had grade crossing work directly parallel to the Southern Pacific's L.A. to Chicago main line. We used the Omni insert crossing and it went together in an amazingly short time. It was just a handful of minutes and we had the whole crossing in place.

We had problems with our concrete panels setting down on concrete ties. There were irregularities in the bottom of the concrete panels. Higher quality control at the plant would probably solve that. Also, we went to clipper pads underneath the concrete panels to help some of that irregularity. So far, it's working, however, we do have light tons on most of the lines. It went together quite well.

The interesting thing is even though we're in LA, we have horses here so we had extreme environmental concerns brought to us by the local groups, citizens and the cities. We spent a lot of time working with those groups, making sure we had covered all permit requirements and responsibilities. Southern Pacific has really joined with us to get this system up and running and in a remarkable way, their forces have committed a lot of effort and time and resource to this and so far, accomplished this quite well.

Probably our greatest single problem was the permit from the San Gabriel River Corps of Engineers' flood control personnel. In addition to that, we had underpasses at the ends of the structure and we had to build parallel to the SP in this case. There was close coordination with the bridge and safety personnel. The SP trains ran at speed during non-construction times and the slow-down agreement was 30 miles per hour during the construction periods so there was a minimal impact to their freight running. In the SP corridor we agreed to build in-kind to the same quality of track and the standards that SP has. The end of the line, the Santa Cerrito station, is another win-win situation where we paid for a line change to straighten out a couple of ten degree curves on the Southern Pacific. So it was a good thing for both of us to get this done. For the rail facilities at the end of the line, we had to deal with the size of property available and make it fit, sometimes it was ten pounds in a five pound bag, a little tricky with derails and switches to put in, but coordinated well with the SP and it's in service today.

What does the future hold? Route extensions, new routes, increased service, extension of the lines with millions of dollars of investments. Cleaner fuels to reduce emissions.

Electrification is a possibility. There is a large contingency working on what to do in southern California with the air quality situation and how to deal with the commuter lines and the freight railroads. The interesting thing so far to date is all three railroads, Southern Pacific, Union Pacific and Santa Fe, have come to terms with agreements we all can live with for the win-win situation.

To do it differently, the main challenge probably was with the consultants in the fact that we proved the need to have railroad personnel within the typical transit consultant groups. And that's been a major challenge with the consultants, they've accepted that and have really moved out on that. Our first teams were selected with aggressiveness to support our time frames, and regardless of what they said they could design, they still lived up to that, so a monstrous effort by that. Also putting staff into the design groups was extremely helpful. So on October 26th, we hope to start the system. Los Angeles is a long way from Chicago, but maybe we can have a conference or committee meeting there and get out on the new trains. I think the most interesting thing about Los Angeles is that it is probably affecting all of us in this room. The new commuter rail starts around the nation are looking to Los Angeles to see what happens with both the agreements with the railroads and the public agencies and how that works out. So far, it's been a success. Next time we'll see the on-time performance of the system and then, improvements over time. Thank you very much. (Applause)

Mr. Brosseau: Thank you very much, John, for that very fine presentation. On behalf of the Roadmasters Association, we'd like to present you with this certificate of appreciation. I'll now turn the podium over to Don Steele who will introduce the next speaker.

Mr. Steele: Thank you, Ray. Our next presentation will be given by Carl Gerhardstein, engineer B&B with CSX Transportation. What we are about to hear was given at the AREA conference last March, however, some modifications have been made to gear it towards the actual bridge repairs. As some of you may recall, CSX had a derailment on a bridge in November, 1991, near Shepardsville, Kentucky, which drew national attention. Carl took an active part in putting this bridge back in service in record time. He received his civil engineering degree from the University of Kentucky and is a registered professional engineer in Alabama. Carl is the bridge and building engineer on the CSX Chicago division. He has been with CSX since 1983.

REPLACEMENT OF BRIDGE AT SHEPARDSVILLE, KENTUCKY

Carl Gerhardstein

Engineer B&B
CSX Transportation Company

On November 19, 1991, at approximately 12: 30 p.m. a garbage truck with an inexperienced driver was rerouted to pick up an additional resident's garbage. The 12 feet 2 inch high truck attempted to pass under CSX's underpass No. 5A with only 10 feet 6 inch clearance. The collision shifted the bridge and track 12 inches out of line.

Within minutes after the collision, a CSX freight train rounded the curve just south of the underpass traveling at approximately 40 miles per hour. The crew noticed the disturbed track but without having sufficient distance to stop, attempted to negotiate the disturbed track section. The train derailed at the underpass and continued north approximately 1,000 feet over CSX's Bridge No. 5 over the Salt River.

CSX's Bridge No. 5 over the Salt River is located within the city limits of Shepardsville, Kentucky, on the main line subdivision, 18.7 miles south of Louisville, Kentucky. This line carries over 26 million gross ton miles of traffic and is located on CSX's line between Louisville, Kentucky, and Nashville, Tennessee.

The resulting 27-car derailment destroyed the two north spans of the Salt River bridge and heavily damaged the remaining span. Bridge No. 5 was a three span double track thru truss and each of the three spans were identical and measured 152 feet 1 inch. The three-unit consist miraculously made it across the Salt River bridge and came to rest just north of the bridge, saving the crew from any harm.

There happened to be a television crew filming near the Salt River bridge at the time of the derailment and they were able to supply CNN with some spectacular footage of the derailment. The resulting publicity of the derailment forced CSX to suspend trading of our stock for a short period of time. This was not the first time the Salt River bridge was heavily damaged. It was burned by Confederate troops on three separate occasions during the Civil War.

An initial assessment was made by CSX officials and later by 66 federal, state and local agencies. The most immediate concern was two cars of hazardous materials. The first car was a load of cluster bombs returning from Operation Desert Storm. It was lying on its side partially down an embankment south of the bridge. The second car was a tank car containing propylene oxide, a flammable liquid, and was derailed on the remaining span of the truss bridge. Of immediate concern was the safety of the local population and the clean-up personnel. A one-mile area around the site was evacuated which affected approximately 2,500 local residents. A command post was also set up one mile from the site.

The initial phase of the derailment, which consisted of the removal of the derailed cars and rebuilding of the track up to the bridge, took three days, working daylight hours. During the derailment the ties on the remaining truss were destroyed, so ties had to be placed under the car of propylene oxide before it could be removed off the bridge.

As the rerailing operation got underway, CSX's engineering department surveyed the bridge and constructed a restoration plan. It was easily recognized that the two north truss spans were completely destroyed and the remaining span was heavily damaged but could be repaired. The remaining span had an end post, one hanger, three diagonals, a section of the number one floor beam, the stringer laterals and a deck of span ties damaged so severely that they had to be replaced or repaired before traffic could resume on the bridge.

Taking into consideration time, costs, manpower, material and equipment availability, it was determined to rebuild, in single track, the previous double track nine-mile section that included the bridge. The previous northbound main was selected to be the new main track. It was decided to construct the single track bridge utilizing four second hand deck plate girder spans in stock at CSX's bridge fabrication shop at Barboursville, West Virginia. Four spans would replace the destroyed two truss spans.

CSX maintains a supply of surplus bridge spans for use in emergency situations and for scheduled bridge replacements. The spans were modified to be used as replacement spans and new shoes were designed to provide proper vertical clearance. Two out of the four new spans required only minor repairs, however, the second two spans were constructed from four welded girder spans having a substandard E60 rating. The four spans were cut apart and new laterals and diaphragms fabricated to convert the four existing E-60 rated spans to two girder per rail spans.

All design and detail drawing work was done by CSX's Bridge Design Department in Jacksonville, Florida. All modifications to the spans and the replacement steel fabrication was performed by CSX crews at our Barboursville, West Virginia, fabrication shop.

After the hazardous material cars were rerailed and the evacuation order lifted, the rebuilding work was started. Due to manpower and equipment limitations, it was decided to contract out the construction of the two new piers and the setting of the four replacement spans.

The limestone river bottom made an excellent foundation for the two new piers required. A hydraulic hoe ram was used to key into the river bottom 12 inches. The footings were reinforced and poured directly on the bedrock. The existing subsurface conditions eliminated the need for driving piling which helped tremendously in speeding up the pier construction. From keying into the bedrock to the final pour took four and a half days. Class "M" concrete which has a minimum cylinder break of 4,800 psi in 24 hours was used in the pier construction.

Shortly after the piers were completed, the replacement spans arrived on flat cars from CSX's bridge repair shop. The cars were spotted on the north approach to the bridge and 60 ton and 80 ton crawler cranes were used to set the new spans. After the first two spans were set, ties and rail were placed on these spans so the final two spans could be spotted for unloading and setting in place.

Simultaneous with the pier construction, CSX crews started on the steel fabrication and repairs on the remaining truss span. The first order of business involved hanging vertical life lines and the construction of adequate work platforms, walkways to provide a safe workplace. CSX Safety Rules including rules requiring the use of fall protection were enforced.

The ties and rail had to be replaced on the damaged span so hi-rail equipment could get access to the work on the north end of the truss span. After this was completed, work started on removing rivets and damaged steel in preparation for the repair steel that was being fabricated in Barboursville. The repair steel was ordered and detailed in the exact order it was to be used and then trucked to the jobsite. Most steel was placed in the bridge within 24 hours of being shipped.

The repair work in the North East section of the truss span consisted of replacing a 10 foot section of the number one floor beam at panel point L1, U1-L1 hanger and M1 L1 diagonal and the top flanges angles and cross frames in stringer panel one. All damaged steel was removed in the northeast section before new steel was erected. The M1-L1 diagonal and the hanger U1-L1 were erected first. Then after the members were bolted in place, the floor beam was cut, the new section was bolted in place and the new splice was added. Spider air powered scaffolds were used in erecting the steel.

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The south end post of the truss span sustained considerable damage when struck by an empty tote car and was bent six to eight inches horizontally. Scaffolding and work platforms were constructed around this member to provide proper access to the work location. Since this member carries substantial dead load, caution had to be taken when splicing in the 20 foot section. This was done by splicing in one piece at a time to keep dead load carrying capacity at all time. Splices were used to join the angles and web plates in this member but since the top cover plate carries compression forces, this member was welded at the splice locations.

The 18 foot underpass that the garbage truck struck was damaged beyond repair and an identical span was taken from the retired southbound main and set in place. Concrete blocks were precast from the same class "M" concrete used in the pier construction to replace the timber blocks the span was setting on.

The repair work on the damaged truss span and underpass was performed by CSX crews working 12 hours a day and took ten days to complete.

Weather conditions for the 17-day project were less than ideal, as it rained, snowed, sleeted and on one day, the wind chill was seven degrees below zero. Due to heavy rains, the Salt River flooded on two occasions, delaying the setting of the last two spans by two days. The Corps of Engineers assisted in minimizing the flooding by holding water back at an upstream dam until the replacement spans were set.

In addition to the bridge work, the following track and signal work was performed because of the elimination of the one main track; 7,200 track ties, two No. 20 turnouts, and two No. 10 turnouts were installed. The signal system for the nine miles of main track was converted from ABS double track to C.T.C. single track.

In summary, to complete a project of this magnitude in a limited time frame takes teamwork and communication from all departments involved. The biggest accomplishment in the 17 days in which over a half million pounds of steel were designed and erected, 320 yards of concrete were poured, 456 bridge ties were installed, not to mention all of the above track and signal work, was that all this work was performed without any personal injuries. Thank you. (Applause)

Mr. Steele: Thank you, Carl.

Our next presenter is Jim Headley, Director, Crane Institute of America. His presentation is entitled Crane Maintenance and Safe Work Procedures.

This next special feature is a topic which should be of vital importance to each and everyone of us, for most of us here come in contact with the use of cranes in our daily work environment.

Jim is a very knowledgeable person in this field. The Crane Institute of America offers training to crane operators and managers on the needs for following precise procedures in the operation of cranes and rigging. They also certify operators in the operation of all types of cranes.

Jim has a bachelor of science degree in education and 16 years experience as a crane operator. He probably could compare many war stories with us. He is widely noted for his unparalleled success in his practicality in communicating the safety and technical aspects of cranes and rigging. Jim provides training for managers, supervisors, operators and riggers world wide and is frequently called on as an expert witness and provides litigation council. Jim is to soon publish two books; "Mobile Crane Safety" and "Safe Rigging". He is a member of the ANSI B30.5 committee on Mobile and Locomotive Cranes. Jim, welcome to this conference.

CRANE MAINTENANCE AND SAFE WORK PROCEDURES

James Headley

Director
Crane Institute of America

Thank you, Don. Anytime you speak before a group, you like to take little assessments to see where people are. If, when I ask you a question, you could respond by raising your hand, I'd appreciate it.

How many in here are concerned about liability? When we talk about liability, are we talking about lawsuits, lawyers, are we speaking the same language? It's at the forefront of my mind since I've got to testify in court Friday and I'm already getting sweaty. Do we have any lawyers in here, an attorney? No.

Anytime you start talking about cranes and rigging, liability is number one on the list. We're in a very litigious society. We can get sued for anything. Normally, that suit is the result of an accident. We have several things to be concerned about. In an accident we have property damage, we've got equipment damage, we've got injured personnel and often times we have people who are killed. As you probably already know there is a big push for prosecution in the workplace. More likely that's going to happen when there is a death. Convictions occur among the managers and supervisors of the deceased employee.

What about cranes and fatalities? Only about one out of every ten accidents are ever reported, according to OSHA. But the best we can determine, somewhere between 20 and 25 percent of all construction fatalities are crane related. So it could be as high as one out of every four. That's a large percentage when you consider on most construction jobs, you only have a few cranes as opposed to everything else that's going on. So some have called cranes the hidden killer. It's an area that we need to focus on. This is an area that is really overlooked.

We all would like to think that our crane operators are qualified. Management and supervisors have responsibility and then you have the crane operator. Over 99 percent of crane operators can't read a load chart. A load chart is the most important thing about the crane because that tells you what you lift and a lot of other things as well.

The accident happened so suddenly! Without warning the crane just collapsed, sending the load crashing through the structure it was intended to set on. The aftermath of the accident was three workers dead and several others seriously injured. No one had ever imagined in their wildest dreams that something as terrible as this could ever happen at their work place.

Even though very heavy, the lift being made was not unusual in any way. Everyone, including the operator, had previously made similar if not identical lifts. The operator stated that he simply lifted the load about 40 feet into the air, swung over the side and was in the process of booming the load into place when the accident occurred. Everyone agreed that when the load was first lifted the crane had plenty of capacity. There was absolutely no hint of a problem. The crane had been set up properly with all outriggers fully extended and firmly set. In fact, one of the workers assigned to watch the outriggers on the opposite side persistently stated that the crane never got light - that the outriggers never came off the ground before the crane collapsed and turned over.

However, an in-depth investigation revealed a totally different set of facts.

- Even though the outriggers never lifted off the ground, the crane was found to be overloaded more than five tons when the structural failure occurred.
- There had been no pre-lift planning by supervision to ensure the safety of the lift.
- The operator had misinterpreted the load chart and consequently thought the crane had adequate capacity.
- The operator had never received any formal training, specifically on how to correctly interpret load charts.
- Perhaps most important was the fact that nothing was done prior to the accident to verify that the operator possessed the required knowledge and practical skills necessary to operate the crane safely.
- To make a lift it typically takes more than one person interfacing with the crane, thus when an accident happens it is rare that the blame would be placed on a single individual. However, from the standpoint of accident prevention, it is evident that this accident would never have occurred had the employer properly trained and certified the crane operator, for it is the operator who is responsible for determining the crane's capacity.

Mobile Cranes Harbor High Accident Potential

Is the use of mobile cranes potentially dangerous? You bet! According to Donald Dickie, internationally known crane expert, "there is still no other piece of equipment that has the potential of causing so much damage or harming so many people as does a crane in an accident." For example, cranes are involved in more serious accidents than other construction equipment; crane accidents cost most in insurance claims, more construction fatalities result from cranes and hoisting equipment than any other cause.

Mobile crane accident statistics are difficult to obtain in the United States. Unless there is a fatality or several serious injuries, the accident is usually not reported. It is estimated that as few as one in ten are ever reported.

However, the Construction Safety Association of Ontario states that approximately 20 percent or one out of every five construction fatalities are crane related. It is interesting to note that although the U.S. percentage has remained the same, the province of Ontario has reduced the percentage of crane related fatalities to about 12 percent through an extensive operator training and certification program.

OSHA Gets Serious About Operator Certification

Crane Operator Certification, a subject of much discussion over the last few years looks like its time has finally come. In conjunction with the Specialized Carriers and Rigging Association, OSHA appears ready to mandate just such a program. When it will occur, what it will entail and how it will be set up, no one yet knows for sure. But there is one thing for certain, the legislation and implementation of a Crane Operator Certification program will, without question, have a tremendous impact on crane owners and accidents as well.

The need for a good crane operator certification program is not something that is new. The need to verify an operator's qualifications before assigning him the responsibility of a crane has always existed. However, the need has escalated through the years and is greater now than ever before.

Cranes Have Changed

The reasons for certifying crane operators are numerous, but perhaps the greatest reason is that cranes have changed dramatically through the years. We are simply not dealing with the same cranes today that we dealt with in years past.

Older cranes were simple machines and in relation to their capacities were very large and heavy. Booms were short. Load ratings were based primarily on tipping and you didn't have to worry much about a structural failure. Load charts were rather simple and contained only a minimal amount of technical information. Knowing the weight of loads was not seen as that important, since operators could easily determine how much the crane could lift by relying on the outriggers coming up. Operator training was almost nonexistent and the training that was available covered mostly excavators not cranes. Determining if an operator was qualified was easy. If he operated the crane in a smooth manner, got the job done and didn't scare anybody, he appeared qualified.

As industry and construction progressed there was a need for cranes to be more versatile, have higher capacities and longer booms. Yet, at the same time road restrictions, size and other considerations required that cranes be lighter in weight. Then something happened that would have a dramatic and lasting effect on the craning industry. Hydraulic cranes began to emerge and evolve.

Being self-contained and possessing a telescoping boom, hydraulic cranes were more versatile and mobile than lattice boom cranes and therefore gained quick popularity. Even companies who had never before owned and operated cranes found that they were indispensable to their operation. This crane would pick and carry its own load, could easily be maneuvered into tight places and at the same time carry a manual section, an extension and a jib which could be erected on a moment's notice. It appeared so easy to operate. You couldn't drop the load. The boom wouldn't fall and like an automobile, some models even had a steering wheel in the operator's cab. Therefore, to many companies the hydraulic crane was thought of as a very simple machine and became a tool for all workers to use.

However, in reality hydraulic cranes are not the simple machines most people perceive them to be. They are very complicated, sophisticated and technically oriented pieces of equipment. Capable of multiple configurations their load charts can be very complex with capacities based totally on structural strength and not on tipping as was the case with some older cranes. In other words, if a crane operator relies on the outriggers coming up to determine if he can handle the load, some part of the crane is likely to incur structural damage or total collapse before tipping occurs. This is exactly what happened in the crane accident described earlier.

But, hydraulic cranes are not the only type cranes to become more complex. All cranes have changed and become more complicated through the years. Utilizing a variety of attachments, booms have become much longer. Capacities are much higher and modern cranes do not have the built in safety factors that once accompanied older cranes.

Some people see this as a problem. Others think that modern crane design has led to an increase in accidents. However, the crane is not the problem! What we have today is a marvelous piece of lifting equipment designed to utilize its full lifting potential.

Rule of Thumb

The main problem, and a problem that currently faces our industry, is the way cranes are currently being operated. Instead of relying on precise calculations, crane operators are still operating by the "seat of their pants." They are still relying on their feel of the machine to tell them when the crane has reached its limit. Being required to operate the crane without adequate training and qualifications, operators have been left with no other choice. This is a sad commentary on our industry, but the fact is that as cranes changed and became more technical, crane operators just have not kept pace.

This is precisely why the formation of a good crane operator certification program is so crucial, whether legislated or not. If properly developed a good certification program would establish and ensure that minimum training requirements had been met and through the administration of physical, written and practical examinations identify any problem areas which could keep the operator from safely operating the crane.

For those crane owners who wish to establish and implement a certification program at their work place, the following is a model used by the Crane Institute of America, Inc. that can be used to verify the competency and qualifications of their crane operators.

Certification Model for Mobile Crane Operators

Requirements for Initial Certification:

Step 1 – Selection

An operator must have a minimum of six months experience operating mobile cranes. The operator must hold a valid driver's license.

Step 2 – Training

The operator must attend a mobile crane safety training program which adequately covers the following topics:

- Identification of Components
- Technical Data
- Pre-Operational Inspection
- Load Charts
- Assembly and Disassembly
- Set up
- Safe Operating Procedures
- Responsibilities
- Basic Rigging
- Applicable Safety Standards
- Hand Signals
- Crane Manufacturer Requirements

Step 3 – Examination

The operator is required to pass a physical examination. The operator is required to pass a qualifying written examination. The operator is required to pass a qualifying practical examination.

Certificate of Qualifications and Competency

If all six requirements are met, the Crane Institute of America, Inc. will issue a Certificate of Competency which is valid for two years from issue date.

Certification verifies that applicable Federal, State and Industry crane safety standards are met.

Certification verifies the operator is competent and qualified to operate the specific type of crane for which examined.

Recertification

Certification of Competency can be renewed for an additional two years if the operator continues to meet the physical criteria and also attends a two day recertification training program.

Employers' Benefits

Identifies those operators who could be a liability having insufficient training.

Certified operators can influence the costs of insurance coverage.

The employer is assured that all crane operators qualifications are met and thus the employer also meets the applicable laws and standards.

Provides documentation in the event of an accident resulting in an OSHA investigation or lawsuit.

Provides additional reasonable assurance of maintaining a safe workplace.

Increases the professionalism of the operator.

Provides the operator with more self-esteem.

Crane operator certification should not be looked upon as a cure-all for crane accidents, but rather to ensure that one link in the chain of people involved in the lift (riggers, crane inspectors and supervisors) is adequately qualified to safely perform his assigned tasks.

Member: How often do crane operators have to be certified?

Mr. Headley: In our certification program, we require an initial certification and then recertification every two years which requires refresher training that they have to pass, and a physical examination, but the industry standards don't require the same thing.

Member: I guess the limiting problem here is determining what the weight is. What kind of training do they get to determine how to calculate material weights so they can make an intelligent lift?

Mr. Headley: That's a very good question. Because everything starts with the weight of the lift. If you don't know the weight of the lift, you're in the dark the whole way. They will get training on calculating weights, estimating weights and also, there are other ways to determine the weight of the lift. For example, engineering drawings, bills of lading. When calculating, you can round things off on the high side and get to it pretty quickly. Load weight indicators are another subject. I'll talk about that next year. Load weight indicators are definitely something that all cranes should be equipped with. That gives the operator a read-out of the tension applied to the crane when he starts picking it up. There are scales, things like that, but you've got to know the weight of the load. If you can't read the load chart, who cares about what the load weighs.

Member: My question is about operating rail bound cranes in an off level position on curves, sometimes up to four and five inches, and the impact of the load charts on calculating safe lifting loads.

Mr. Headley: What has happended when a crane is off level is that the center of gravity of the crane has moved forward. Crane ratings in the load chart are based on the crane being less than one percent, that's almost perfectly level. If you lift the load throughout the entire lift, which is almost impossible, and when you further aggravate that problem, or increase the crane being unlevel, then you've decreased the capacity of the crane, structurally and stability wise. In training, you would explain that to the operators and in the load charts, the manufacturer tells you you have to take into consideration it being off level. In other words, you reduce the capacity of the crane which would mean that you couldn't lift as much weight.

Member: For certifications and everything, at what point does it actually become a crane? We've got a lot of varied capacity boom trucks on the railroad.

Mr. Headley: What's a mobile crane? Well you saw a lot of pictures of them in the accidents. A boom truck, these cranes on the back of trucks, are a mobile crane. They come under the Mobile and Locomotive Crane Standard ANSIB 345 written by the ASME and there's a picture of them in there. They are rated using the same criteria as all the other cranes are. They require qualified operators just like everybody else does. Obviously, an operator may not have to have as extensive training on one as he would on a bigger crane or a different type crane. Now it's interesting, people buy these 12-15-tons capacity, that rating is based on a four-foot radius. So it's a ten ton crane at four foot, it's not really a ten ton crane.

Member: What criteria is used for the medical checkups or certification?

Mr. Headley: The ANSIB 345 standard, which is the industry standard covers all industries using mobile cranes. We give that list to the doctor to check off.

Member: One other standard that needs to be considered, particularly in the railroad application is B30.22, as it concerns to articulating of knuckle boom cranes.

Mr. Headley: The B30.22 is a knuckle boom crane and I think most of you can remember that. For all practical purposes, it is the same thing, it just doesn't hoist. The standard that would address that is B30.22.

If I can help you in any way, I'd be glad to do it. (Applause)

Mr. Steele: Our last feature is on a topic that some of us encounter and others may not. It is the difference of sand, wind and snow. Dr. Ron Tabler is president of Tabler and Associates from Niwot, Colorado. He is an independent consultant in wind and snow engineering, adjunct professor in the mechanical department at the University of Wyoming, and an affiliate of the Geophysical Institute's University of Alaska.

Over 125 public and private clients have utilized his professional expertise in training and solving problems. Ron has written 83 reports and publications concerning snow, wind and sand management. He has received many prestigious awards such as U.S.A. Service Honor Award, D. Grant Mickle Award from the National Academy of Sciences, Research Award for Foreign Specialists from Japan Science and Technology Agency, and Award for Best Paper 1985 Western Snow Conference. He is a member of numerous organizations, one of which is AREA. It gives me great pleasure to present to you Dr. Ron Tabler.

WHAT'S NEW IN FENCING FOR SNOW, WIND AND SAND

Dr. Ron Tabler

Tabler Associates

Introduction

Technological advances in rail transportation have increased the need to control environmental factors affecting operations. Successful operation of remotely controlled switches, for example, requires that switch points be free of snow, ice and sand. Thermal scanners used for hot-box detection are also susceptible to dysfunction when wind-deposited material blocks the optical path and dragging-equipment detectors are disabled by snow and ice accumulations. The advent of intermodal freight operations has brought an incentive for wind control, because high-profile double-stacked container and trailer loads have proven vulnerable to wind-caused derailments.

Although these examples make clear the need for controlling snow, sand and wind, the construction of new fences on railways has generally declined since the 1950's. Maintenance on existing fences has often been deferred, and fencing design and guidelines have largely remained unchanged since snow fences were first used on the Union Pacific Railroad in the 1870's. Although efforts are underway to correct the deficiency, the snow fence guidelines in the American Railway Engineering Association (AREA) manual are woefully outdated and superficial. Although this oversight is shared by many state and local road departments, railroads have the most to gain from improved fencing technology. It seems apparent that expenditures for fence systems could easily be amortized by eliminating delays caused by inoperable switches and thermal scanners. The prevention of a single derailment can pay for the most expensive fence system. Finally, as C. B. May of the Burlington Northern Railroad pointed out back in 1988, there is great potential for using wind fences to reduce fuel costs.

The last 20 years have seen major improvements in fencing for environmental control. The purpose of this presentation is to bring these improvements to the attention of the rail road industry.

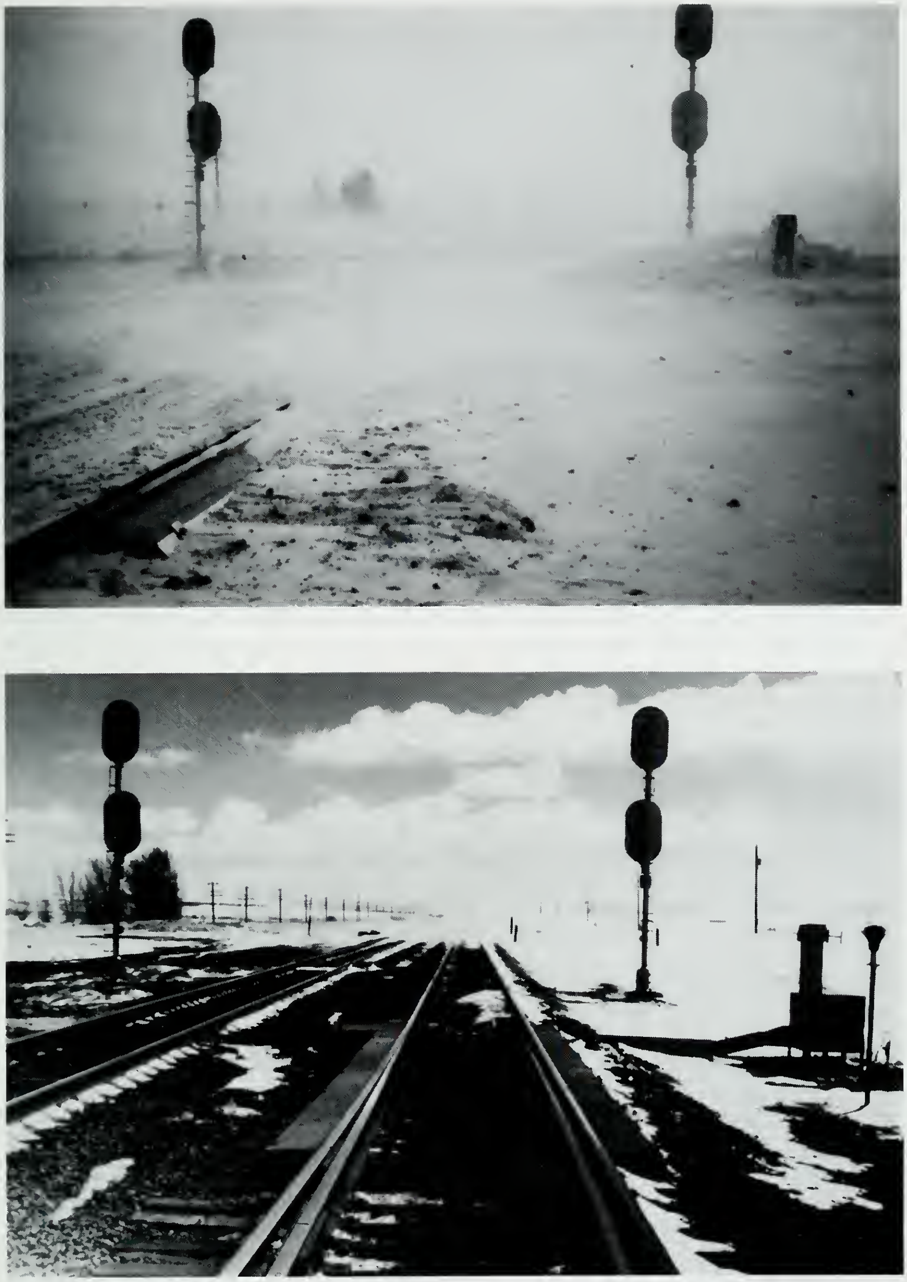

Figure 1. **Comparison of snow conditions at switch before *(top)* and after *(bottom)* building a snow fence at Wilcox, Wyoming. Top photo by Steven R. Andersen, Environmental Research and Technology.**

Improvements in Snow Fences

Modern snow fence systems have proven effective in preventing drifts, improving visibility, and reducing road ice on highways, where benefit/cost ratios as high as 80:1 are typical. As a result, state highway departments in Wyoming, Arizona, and Montana, and oil companies operating at Prudhoe Bay in Alaska, have invested many millions of dollars in extensive snow fence systems over the last 15 years. Snow fences have also been used successfully to protect roads, villages, and airstrips in the Alaskan arctic.

These past applications have shown that properly engineered fence systems can reduce blowing snow by as much as 95 percent, suggesting that fences can be used by railroads to solve the challenging problems of snow accumulation in switch points and at thermal scanners, as well as to prevent drift encroachment on tracks and to improve winter-time trackside access. The few applications of new snow fence technology on railroads consist of five fence systems comprising over 28,000 feet of 9- to 14-foot tall fencing, constructed in Wyoming by the Union Pacific Railroad to protect thermal scanners and switches. The comparison of snow conditions at one of these locations before and after installing a new snow fence system in 1980, shown in Figure 1, provides a striking example of the effectiveness of properly designed snow fence systems.

The most important breakthrough in snow fences has been the development of a reliable method for estimating how much blowing snow arrives at a problem location over a typical winter. Because the snow storage capacity of snow fences in relation to height and other characteristics is also known, it is now possible to size a snow fence in much the same way as a culvert is sized to accommodate storm runoff. Extensive field measurements over the last 20 years have proven that the snow storage capacity of fences is proportional to fence height raised to the 2.2 power. Because construction costs for snow fences are linearly related to fence height, it is clearly more economical to build a single tall fence rather than a series of shorter fences having the same storage capacity. Tall fences are also more effective than shorter ones because the snow trapping efficiency increases with fence height. The 14-foot tall fence shown in Figure 2 can store more than 60 tons of snow per lineal foot of fence, which is sufficient capacity for total protection at all locations on U.S. railways.

Other improvements include effective guidelines for placement, improved fence designs maximize snow trapping efficiency and minimize construction and maintenance costs; and new fencing materials reduce maintenance requirements.

New fence designs make snow fences affordable. Total costs for materials and installation for the 14-foot fence shown in Figure 2, for example, have averaged under $13.00 per lineal foot for the last five years, and bid prices of $10.00 per foot have not been unusual for larger projects. These fences are anchored to the surface using driver rebar anchors and specially designed steel U-clips. Where pole-supported fences are preferable on agricultural lands because of their narrower footprint, plastic fencing materials allow vertical supports to be spaced up to 15 feet apart, and have a useful life of 15 years or more when properly installed (Figure 3). A polyethylene strap with three, 12.5 gauge embedded steel wires, provides an especially durable material that can also be used for sand or wind fences (Figure 4). This product, which was initially developed for horse and livestock fencing, is manufactured by Centaur HTP Fencing Systems in Muscle Shoals, Alabama.

Work is underway to update the AREA Manual's fencing section to incorporate some of the new guidelines for snow fences. In the interim, specific guidelines and procedures are described in the "Snow Fence Guide" published by the Strategic Highway Research Program (SHRP), as listed in the selected references at the end of this paper. A more comprehensive treatment, "Drifting Snow Design Manual," is being prepared by the author and will be available from SHRP in 1993.

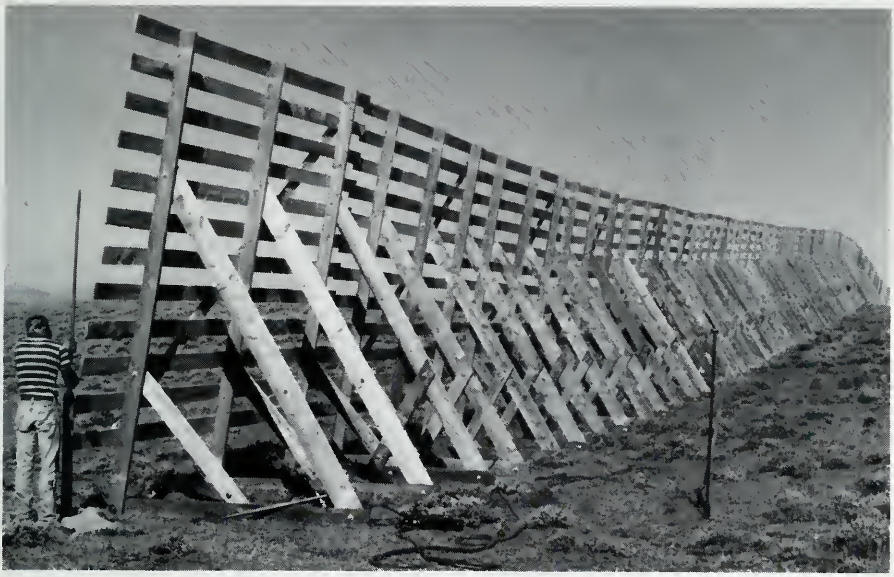

Figure 2. "Wyoming"-type snow fence, 14 feet tall, as used on the Union Pacific

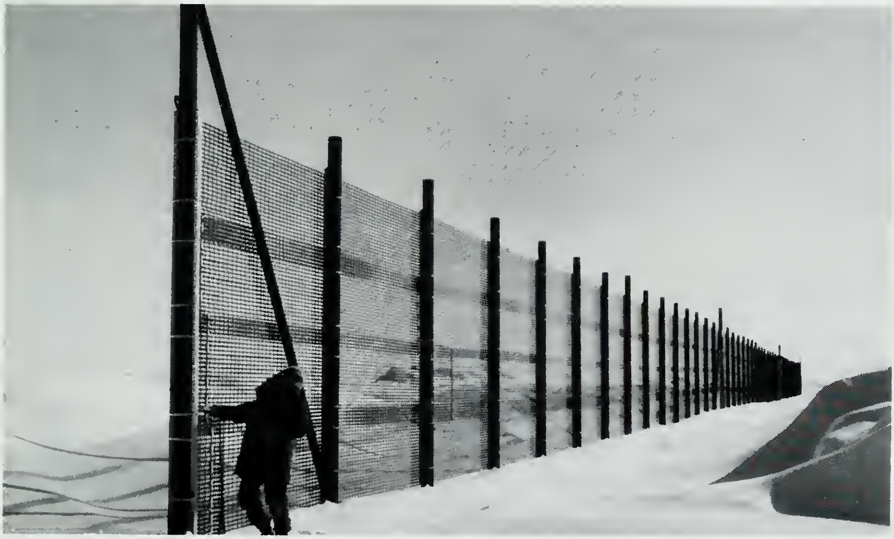

Figure 3. A typical 15-ft. snow fence at Prudhoe Bay, Alaska, constructed from high density polyethylene manufactured by the Tensar Corporation.

Improvements in Sand Fences

Although the potential for effective sand control is equally as great as that for snow control, there have been no applications of modern fencing systems to serve as examples. There are examples, however, of the effectiveness of new guidelines, even when used in conjunction with traditional fencing materials. Figure 5 shows how properly spaced fences have stabilized a highly erodible embankment of mill tailings. A system of over 50,000 feet of four feet of fencing at this project site provided complete stabilization of over 100 acres.

Historically, dust levees have been used for protecting railways on the Great Plains, and plantings of tamarisk trees, also known as salt cedar or Athel, have proven effective along railways in southern California and other locations in the southwest. Past experience showed conventional four or six foot tall fences became buried, and hence ineffective, after only a year or two. Where earthen embankments are practical and where they can be stabilized, they can provide effective protection. But with the new guidelines available, fences offer a cost-effective alternative suitable for all locations. Unlike trees, structural fences provide uniform, predictable protection, require no watering, and are unaffected by insects, disease, and freeze damage as occurred to trees in the Mojave Desert over the 1990-91 winter.

The wind transport of sand and snow are sufficiently similar that many of the guidelines applicable for snow fences apply to sand fences as well. But because sand deposits do not melt each year, the storage capacity of the containment systems must be sized on the basis of long-term sand transport. As with snow fences, the key to successful control is to be able to predict the quantity of blowing sand at a prospective site, and then size the containment fences accordingly. Methods are available for estimating the mean annual transport of blowing sand using historical wind data or geological information, and the sand storage capacity of fences is known.

As with snow fences, particulate trapping efficiency and economy increase with fence height. Sand storage capacity is proportional to the square of fence height. A 14-foot fence, for example, would hold 12 times as much sand as a four foot fence, and would have a useful life of at least seven years in the highest sand transport areas in the Mojave Desert. A sand control fence system could be designed to have a much longer effective life by planning for staged increases in fence height and by adding rows of fencing upwind.

Other improvements in sand control fences include improved placement criteria maximize effectiveness and allow for future additions of fences to augment storage capacity; use of tall fences improves cost effectiveness and sand trapping efficiency; new materials are available for both permanent and temporary fences, including a new polyethylene/steel wire composite strap; improved structural guidelines reduce costs for construction and maintenance.

Wind Fences

Over the last ten years, field measurements utilizing computer-controlled data acquisition equipment have provided maps of wind speed reduction behind fences having a variety of porosities and heights. Knowing how the vertical distribution of wind speed reduction behind a fence varies with downwind distance, it is possible to specify the height, porosity, and placement of a fence to affect the desired reduction in wind speed.

The development of strong, durable synthetic fencing materials has also contributed to the feasibility of building tall fences for wind protection. Plastic fencing materials are relatively inexpensive, easily installed, and relax constraints on the spacing of vertical supports.

Wind fences, up to 24 feet tall, have been used successfully to eliminate swinging and derailments on ropeways (Figure 6), demonstrating that fences can also be used to prevent wind-caused derailments on railways. Over the 1991-92 winter, the Burlington Northern constructed a 2,500-foot long wind screen at a location near Browning, Montana, having a history of derailments occurring in strong winds. The problem track is on a 20- to 60-foot

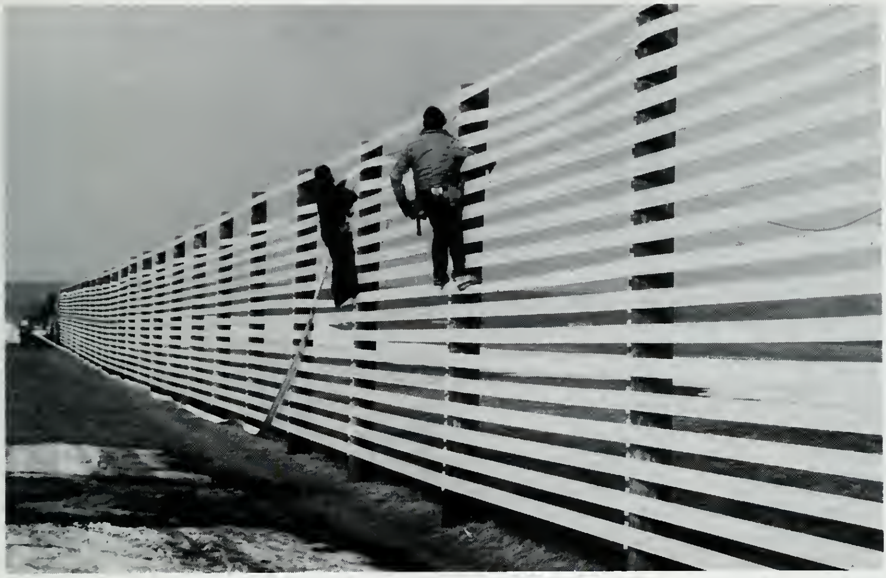

Figure 4. Flexible Centaur rail made from plyethylene with embedded steel wires is a strong, durable material suitable for all types of fences.

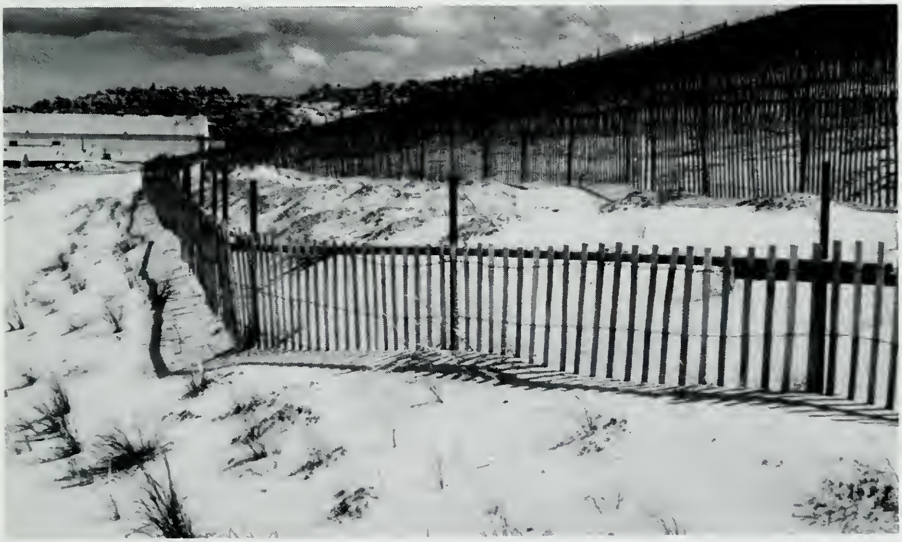

Figure 5. The successful stabilization of this highly erodible embankment illustrates the effectiveness of new guidelines for using fences to stabilize and control blowing sand.

high fill and a three degree curve, with a six inch superelevation on the upwind rail. As a result of their exposure and the center of gravity offset on the curve, 26-foot high double-stacked container and trailer loads are exceptionally vulnerable to the strong winds typical in this area.

The Browning fence (Figure 7) utilizes high-density polyethylene Tensar windbreak fencing over the 2,036-foot long curved portion of the fence. The 37 percent open area (porosity) of this material reduces wind speed at track center line by more than 50 percent. The ends of the fence were extended tangentially for a distance of 300 feet to help phase out wind protection and to reduce the accelerated flow that normally occurs around the ends of barriers. In addition to gradually increasing the distance between track and fence, the transition from sheltered to exposed conditions was made even more gradual by increasing the porosity to 62 percent for 156 feet, and to 74 percent over the last 144 feet. Variable porosities were achieved by using different spacings between five inch wide Centaur composite rail.

A potential problem with wind fences in the snowbelt is that, unless properly designed, they can induce large snowdrifts on the tracks. The increased porosities used near the ends of the fence reduce this problem, but additional measures are necessary. At the Browning fence, a four-foot gap was left between the ground and the bottom of the fencing to accelerate the wind near the ground, which in turn displaces the drift away from the fence sufficiently to keep the tracks free of snow. Because there is a greater tendency for snow to be deposited at the ends of a fill, 14-foot snow fences were installed upwind of these locations as an additional precaution.

Conclusions

Although this presentation has distinguished between fences used to control individual elements, the state of the art makes it possible to design a structure that could serve the multiple functions of controlling access, stopping blowing snow or sand, and reducing wind loads on trains to prevent derailments as well as to reduce fuel consumption. The potential for using wind fences to reduce fuel costs would seem to warrant an industry-wide study encompassing both theoretical modeling and field experimentation.

Effective guidelines and materials are now available for fences to control blowing snow, sand, and wind. Potential benefits to railroads are clear, but the non-traditional nature of the subject matter makes it difficult for engineers to become proficient in these areas without special training. This shortage of expertise will slow the adoption of this technology by railroads until successful demonstration projects have reached critical mass, and this will not be possible without the support of management. Thank you very much. (Applause)

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President Hill: Thank you Don and thank you Dr. Tabler.

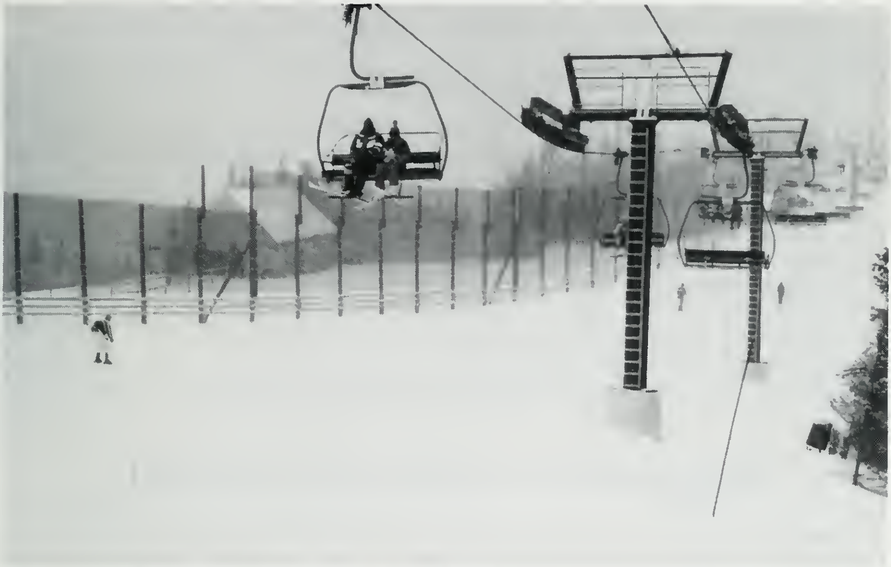

Figure 6. **This 26-foot-tall wind fence reduces chair swing on a ropeway.**

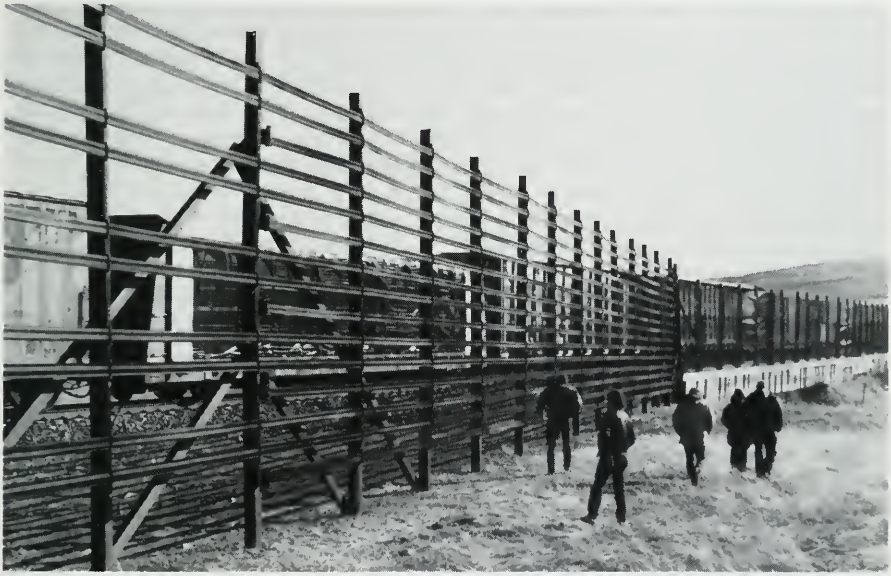

Figure 7. **Wind fence on the Burlington Northern Railroad**

At this time I would like to take the opportunity to present plaques to the outgoing directors in recognition of the job they have done. I would like to call Johnny Johnson and Ken Koff to the podium. The plaque reads, "Roadmasters and Maintenance of Way Association of America presented for services as director 1987-1992."

I would also like to call on Keith Nordlund to present him with a plaque in recognition for having served as treasurer during the past year. I'll now turn the podium over to Mark Walbrun.

President Walbrun: Thank you, Steve. I would like to call our outgoing directors, Doug DeBerg, Don Sorgenfrei and Joe Lileikis to the podium to receive their plaques that read "American Railway Bridge and Building Association Director for the years 1989-1992."

President Hill: At this time, I'll ask Ken Johnson to present the Resolution Statement.

RESOLUTION COMMITTEE REPORT

Having reached the closing of the annual joint conference of the Roadmasters and Maintenance of Way Association of America and the American Railway Bridge and Building Association and being deeply indebted to all those members and friends who have contributed their time and efforts to make our conference a success, it is right that we should acknowledge this indebtedness, and that it shall be so entered into the minutes of this meeting.

Be it further resolved, that our deep appreciation be extended to those who have honored our associations with their presence and by their informative addresses. Those include; Dennis S. Sullivan, executive vice president and chief operating officer, Amtrak; Neal Foot, vice president and chief operating officer, CP Heavy Haul U.S.; Michael W. Franke, vice president of the American Railway Engineering Association; Josef Neuhofer, president Railway Engineering Maintenance Suppliers Association; D. Keith Nordlund, CN Railway; Vincent R. Terrill, Sr., REMSA and Terrill Track Consultants; Jim Kenny, vice president, Kenny Construction; Latham Mortensen, Central Community College; Mike Selway, C&NW Transportation Company; Paul A. Tarvin, STS Consultants, Ltd.; Wayne Parks, CSX Transportation; Larry Anderson, Illinois Central Railroad; Ray Tallent, Norfolk Southern Corporation; Steve McIntyre, UP Railroad; Michael E. Larson, C&NW Transportation Company; Bill Dowd, HDR Engineering; Ron Jeffree, Berminghammer, Corporation; Dennis Peters, UP Railroad; William GeMeiner, C&NW Transportation Company; Peter Giglio, Sinco Products; Robert Kuhn, UP Railroad; Dewey Walls, SP Transportation Company; Michael Beitzel, Modjeski & Masters; John Rinard, Metrolink; Carl Gerhardstein, CSX Transportation; Jim Headley, Crane Institute of America; Ron Tabler, Tabler Associates; and to all the committee chairmen and sponsors, who with the loyal cooperation of the committee members, prepared the interesting and instructive reports that have been presented. Be it further resolved that a very special thanks is expressed to Josef Neuhofer, president of REMSA, and to all members of the Railway Engineering Maintenance Suppliers Association for the fine reception and hospitality that we enjoyed during our conference. Our thanks are also expressed to Mrs. Ellen Hill, Mrs. Laurie Walbrun and Frances Dachs, and their committee members for their efforts in arranging registration and entertainment for our wives. Our thanks also to Julie Beatty and RonnDa Swanson, Rosanna Morales, Kevin Malec and the Westin Hotel staff whose outstanding efforts contributed to a highly successful conference. A special thanks goes to Pat Weissmann and Barbara Marlow. Without their unselfish assistance, these two Associations would have great difficulty functioning.

And be it finally resolved that both Associations express their heartfelt thanks to our retiring presidents, Stephen Hill and Mark Walbrun who have spent so much time and effort in guiding the activities of our two Associations with great efficiency and dedication during the past year.

I move these resolutions be adopted.

Respectfully, submitted,

Ken Johnson
Chairman, Resolutions Committee

President Hill: Thank you, Ken. I would like the immediate past president of the Roadmasters Association, Jerry Cossel, to install the officers-elect of the Roadmasters and Maintenance of Way Association for 1992-1993. And Ray Tallent who is standing in for John Horney, immediate past president of the American Railway Bridge and Building Association, to install next year's B&B officers. Jerry and John.

JOINT INSTALLATION OF OFFICERS

Mr. Cossel: The Following is the list of the officers-elect of the Roadmasters and Maintenance of Way Association of America for the administrative year 1992-1993. The officers so named please step forward in front of the podium. For president, Ken Welch, assistant vice president environmental management, Union Pacific, Omaha, Nebraska; first vice president, Gene Schubel, division engineer, Burlington Northern, Springfield, Missouri; second vice president, Keith Nordlund, project manager, Canadian National Railway, Toronto, Ontario; treasurer, Ken Koff, project manager, Southern Pacific, Springfield, Illinois. For directors with terms expiring in 1995, A.J. Cloutier, assistant division engineer, Amtrak, Riverdale, California; Reuven Shiloh, director of engineering planning and support, Conrail, Philadelphia, Pennsylvania; Pete Murgas, engineer procedures and administration, Norfolk Southern, Atlanta, Georgia.

Mr. Tallent: The following is a list of the officers-elect of the American Railway Bridge and Building Association for the administrative year, 1992-1993. The officers so named please step up and take a position in front of the podium. For president, Paul Saletnik, engineer of buildings, C&NW, Chicago, Illinois; senior vice president, Don Steele, manager of bridge construction, Union Pacific Railroad, Omaha, Nebraska; junior vice president, John Van Huis, chief engineer structures and production, Wisconsin Central, Fond du Lac, Wisconsin; junior vice president, Mike Bradley, project engineer, Conrail, Dublin, Ohio. For directors with terms ending in 1995, Lee Hostler, structural engineer, Santa Fe Railroad, Albuquerque, New Mexico; Jimmy Neece, supervisor B&B, CSX, Helena, Alabama; Ron Kaye, senior project engineer, structures, Elgin, Joliet & Eastern Railway, Joliet, Illinois. Election to a position of leadership in any organization is an honor not to be taken lightly. Your fellow members, in electing each of you to your respective office, have expressed confidence in you. First, that you are to discharge your several duties with distinction. Second, that you are willing to do so.

Mr. Cossel: As the officers of our Associations, you will represent to the citizens of this country the true meaning of railway bridge and building and roadway maintenance and construction. You will be our collective voice in the industry. Thus, you will be our common bond with railway personnel throughout the United States and the world.

Mr. Tallent: As the officers of our Associations you will represent our best interests in any of our activities or projects, always reminding yourselves that your attitude must be a part in any undertaking sanctioned by your respective Associations. In this you will be adhering strictly to the constitution and by-laws of our associations.

As a representative of the American Railway Bridge and Building Association, I install each of you in the office to which you were elected in your Association.

Mr. Cossel: As a representative of the Roadmasters and Maintenance of Way Association of America I install each of you in the office to which you have been were elected in your Association. Please remain standing so Mr. Tallent and I may come down and congratulate you. The audience many now applaud. (Applause)

President Hill: At this time I would like to call on Joe Neuhofer, president of REMSA.

Mr. Neuhofer: On behalf of REMSA, I congratulate the American Railway Bridge and Building Association on the selection of Paul H. Saletnik as president and the president of Roadmasters and Maintenance of Way Association of America, Kenneth Welch. Will you please come to the podium? As a token of our appreciation of our good relationship with your two organizations, it has been a long standing tradition with REMSA to present the gavels to the incoming presidents. The gavels are symbols of high office and please keep it in that manner.

The Roadmasters and Bridge Building Associations have been blessed with the able leadership of Mr. Steve Hill and Mr. Mark Walbrun. It is now an honor for me to present both gentlemen with commemorative plaques which is an expression of REMSA's appreciation. (Applause) Thank you very much. (Applause)

President Hill: I want to thank all of you. I'm coming to the culmination of eight years of being on the board. It's been a lot of fun. I look forward to working with the upcoming board and the tasks they will have ahead of them as we prepare for what promises to be probably the biggest year we've had in a long, long time, the equipment show in Denver with REMSA. At this time, I would like to have Ken come forward. I have a president's pin and I'll turn it over to you, good luck. (Applause)

Mr. Welch: Well, I promise you I'll keep my remarks brief. First of all, I want to thank you. This is an honor I never would have dreamed would have come to me, maybe 15, 20 years ago when I joined the organization. Secondly, I want to assure you that you have a core of able-bodied directors and we sincerely understand what goes with the responsibility. As Steve indicated, we expect to have a great big show next year, the biggest we've had in a long time. And, it's going to take a lot of work and a lot of people to put that together. Without any further comments, I want to see you all in Denver. I want you all to go back and pass out a lot of applications so everybody can come to Denver.

Steve, will you come back up? This is a plaque from the board of directors and the organization to Steve. It says, "Appreciation Award presented from the Roadmasters and Maintenance of Way Association of America, to Stephen F. Hill for his services as president, 1991-1992." (Applause)

I have a survey sheet, I know each one of you has of these, we need you to fill these out. We have boxes at the back door. Fill out any last speakers that you haven't checked off. We need this information to help improve the next conference.

With that, I'll turn it over to Paul.

Mr. Saletnik: Thank you. It is indeed an honor and a privilege to serve as president of the organization. Back in 1974 when I just got out of school and started working at the North Western, I worked for Bill Armstrong, a past president of the B&B Association. He first introduced me to our associations. He happened to be the hotel arrangement committee chairman and I started off by being his main go-fer and getting things worked out. At that time, I never dreamed I would become president of the organization. Since then, and because of those times, I have developed some great relationships and met some eloquent people who have encouraged me to carry on. Two of whom I would like to mention specifically Mr. Walt Hyma and Jerry Iwinski. I was off the board for awhile and when I came back, I noticed a distinct difference in the board and the board's attitude. Back in the 1970's and 1980's the board seemed to be a little bit conservative and went by some rigid tradition. But when I got back on the board the big difference was that things are starting to loosen up and due to the times and our changing industry, the board became a little innovative, tried some new things, and has even been called progressive. With that point being illustrated, I would like to say that I sincerely feel that the example and attitudes portrayed by Mark Walbrun is one of the primary reasons we see that difference in our association. Mark, would you please come up to the podium so I can present you with your president's plaque.

Mr. Walbrun: Thank you, Paul. This has been a very long eight years. I really appreciate all of the effort. I worked with some of the best people in the rail industry involved in these boards and it has really raised my perceptions as to the capability of our industry. There is no way we can fail with the people we have. In over eight years we have rewritten our constitution, we have changed to a seminar format, we have redone the operation of the entire organization, we changed finance systems, we've gone from a period of having almost no money to a situation where we can now launch activities and be fairly well assured that if we make any mistakes or fail, we're not going to send the organizations plummeting down into nothing. A large part of my gratitude goes to Pat Weissmann and Barbara Marlow. The work and the help they've given me over the last few years has been extraordinary and there's no way we could have accomplished it without them.

Mr. Saletnik: I know we're all going to be looking forward to the colossal event in Denver, September 19 to the 22. Let's begin thinking about that now. On that note, I hereby adjourn this year's session.

Left to Right: **P.H. Saletnik, D. L. Steele, M. L. Bradley, J. L. Hostler, J. L. Neece, R. W. Kaye.**

THE WESTIN HOTEL

WESTIN HOTEL

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	1891-1892	1892-1893	1893-1894	1894-1895
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	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

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1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
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Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	L. J. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. G. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
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	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
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3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	W. O. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
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Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911–1912	1912–1913	1913–1914	1914–1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullen	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915–1916	1916–1917	1917–1918	1918–1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919–1920	1920–1921	1921–1922	1922–1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnson	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923–1924	1924–1925	1925–1926	1926–1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	P. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927–1928	1928–1929	1929–1930	1930–1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934–1935	1935–1936	1936–1937	1937–1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938–1939	1939–1940	1940–1941	1941–1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	. . . .	. . . .	F. O. Whiteman	A. G. Shaver
Treasurer	. . . .	. . . .	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942–1943	1943–1944	1944–1945	1945–1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

† To November 1, 1942 ‡ To February 1, 1943

	1946–1947	1947–1948	1948–1949	1949–1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950–1951	1951–1952	1952–1953	1953–1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954–1955	1955–1956	1956–1957	1957–1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. H. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. VonSprecken
	H. D. Curie	E. R. Schlaf	T. M. VonSprecken	W. H. Bunge
	J. M. Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958–1959	1959–1960	1960–1961	1961–1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962–1963	1963–1964	1964–1965	1965–1966
President	J. M. Lowry	E. R. Schlaf	R. C. Baker	H. M. Wilson
1st V.-Pres.	E. R. Schlaf	R. C. Baker	H. M. Wilson	R. D. Hellweg
2nd V.-Pres.	H. A. Matthews	Shirley White	R. D. Hellweg	J. W. DeValle
3rd V.-Pres.	R. C. Baker	H. M. Wilson	J. W. DeValle	W. F. Armstrong
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	E. F. Snyder	E. F. Snyder	E. F. Snyder
Directors	Shirley White	R. D. Hellweg	W. F. Armstrong	J. A. Goforth
	H. M. Wilson	F. W. Hutcheson	J. S. Ellis	E. R. Simmons
	R. D. Hellweg	W. F. Armstrong	J. A. Goforth	N. D. Bryant
	F. W. Hutcheson	J. W. DeValle	E. R. Simmons	A. R. Dahlberg
	W. F. Armstrong	J. A. Goforth	N. D. Bryant	J. S. Ellis
	J. W. DeValle	E. R. Simmons	A. R. Dahlberg	T. L. Fuller

	1966–1967	1967–1968	1968–1969	1969–1970
President	R. D. Hellweg	J. W. DeValle	W. F. Armstrong	J. A. Goforth
1st V.-Pres.	J. W. DeValle	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg
2nd V.-Pres.	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg	T. L. Fuller
3rd V.-Pres.	J. A. Goforth	A. R. Dahlberg	T. L. Fuller	N. D. Bryant
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	N. D. Bryant	J. S. Ellis	N. F. Lucas	W. H. Rankin
	A. R. Dahlberg	T. L. Fuller	W. L. Short	E. E. Runde
	H. F. Lucas	R. A. Youngblood	C. E. Wachter	T. A. Reynolds
	J. S. Ellis	H. F. Lucas	A. C. Jones	J. J. Ridgeway
	T. L. Fuller	W. L. Short	W. H. Rankin	J. R. Williams
	R. A. Youngblood	C. E. Wachter	E. E. Runde	J. W. Chambers
	V. D. Raessler	A. C. Jones	T. A. Reynolds	R. E. Frame
	W. L. Short	W. H. Rankin	J. J. Ridgeway	J. C. Hobbs
	C. E. Wachter	E. E. Runde	J. R. Williams	

	1970–1971	1971–1972	1972–1973	1973–1974
President	A. R. Dahlberg	T. L. Fuller	N. D. Bryant	E. E. Runde
1st V.-Pres.	T. L. Fuller	N. D. Bryant	E. E. Runde	J. J. Ridgeway
2nd V.-Pres.	N. D. Bryant	E. E. Runde	J. J. Ridgeway	J. R. Williams
3rd V.-Pres.	E. E. Runde	J. J. Ridgeway	J. R. Williams	W. R. Rankin
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	T. A. Reynolds	J. W. Chambers	R. K. Corbett	D. C. Gould
	J. J. Ridgeway	R. E. Frame	J. R. Iwinski	W. S. Stokely
	J. R. Williams	J. C. Hobbs	J. S. Pritchett	W. C. Sturm
	J. W. Chambers	R. K. Corbett	D. C. Gould	J. W. Davidson
	R. E. Frame	J. R. Iwinski	W. S. Stokely	C. A. Hughes
	J. C. Hobbs	J. S. Pritchett	W. C. Sturm	W. R. Hyma
	R. K. Corbett	D. C. Gould	J. W. Davidson	O. C. Denz
	J. R. Iwinsky	W. S. Stokely	C. A. Hughes	R. C. McMaster
	J. S. Pritchett	W. C. Sturm	W. R. Hyma	W. E. Brakensiek

PAST OFFICERS

	1974-1975	1975-1976	1976-1977	1977-1978
President	J. J. Ridgeway	J. R. Williams	W. H. Rankin	J. R. Iwinski
1st V.-Pres.	J. R. Williams	W. H. Rankin	J. R. Iwinski	W. C. Sturm
2nd V.-Pres.	W. H. Rankin	J. C. Hobbs	W. C. Sturm	D. C. Gould
3rd V.-Pres.	J. C. Hobbs	J. R. Iwinski	D. C. Gould	J. W. Chambers
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	J. W. Davidson	W. E. Brakensiek	J. W. Chambers	W. J. Gunkle
	C. A. Hughes	O. C. Denz	M. Noyszewski	W. E. Halley
	W. R. Hyma	R. C. McMaster	W. J. Gunkle	K. L. Wammell
	W. E. Brakensiek	F. R. Lindsay	W. E. Halley	J. Budzileni
	O. C. Denz	M. Noyszewski	K. L. Wammel	B. J. King
	R. C. McMaster	W. C. Sturm	J. Budzileni	J. G. Robertson
	F. B. Lindsay, Jr.	W. J. Gunkle	B. J. King	O. C. Denz
	M. Noyszewski	W. E. Halley	J. G. Robertson	E. C. Patterson
	Jim Payne	K. L. Wammel		W. S. Stokely

	1978-1979	1979-1980	1980-1981	1981-1982
President	W. C. Sturm	D. C. Gould	J. W. Chambers	W. R. Hyma
Sr. V.-Pres.	D. C. Gould	J. W. Chambers	R. C. McMaster	O. C. Denz
Jr. V.-Pres.	J. W. Chambers	R. C. McMaster	W. R. Hyma	J. Budzileni
Jr. V.-Pres.	R. C. McMaster	W. R. Hyma	O. C. Denz	J. M. Williams
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Pat Weissmann
Treasurer	W. F. Armstrong	W. F. Armstrong	W. F. Armstrong	W. C. Sturm
Directors	J. Budzileni	O. C. Denz	J. W. Davidson	D. A. Bessey
	B. J. King	W. J. Gunkle	C. M. Russell	J. N. Michel
	J. G. Robertson	W. S. Stokely	J. M. Williams	P. H. Saletnik
	O. C. Denz	L. D. Green	D. A. Bessey	O. D. Anthony
	E. C. Patterson	C. M. Russell	J. N. Michel	J. T. Kapp
	W. S. Stokely	J. M. Williams	P. H. Saletnik	D. J. Lewis
	L. D. Green	D. A. Bessey	O. D. Anthony	J. W. Davidson
	C. M. Russell	J. N. Michel	J. T. Kapp	H. J. Laga
	J. M. Williams	P. H. Saletnik	D. J. Lewis	A. S. Uppal

	1982-1983	1983-1984	1984-1985	1985-1986
President	O. C. Denz	J. Budzileni	J.M. Williams	D. A. Bessey
Sr. Vice President	J. Budzileni	J.M. Williams	D.A. Bessey	J. T. Kapp
Jr. Vice President	J. M. Williams	D.A. Bessey	J.T. Kapp	D. J. Lewis
Jr. Vice President	D. A. Bessey	J.T. Kapp	D.J. Lewis	R. A. Tallent
Secretary	P. A. Weissmann	P.A. Weissmann	P.A. Weissmann	P. A. Weissmann
Treasurer	P. H. Saletnik	P.H. Saletnik	P.H. Saletnik	J. M. Williams
Directors	O. D. Anthony	J.W. Davidson	T.E. Kuhn	B. T. Burns
	J. T. Kapp	D.J. Lewis	D.R. Ladner	J. J. Horney
	D. J. Lewis	T.E. Kuhn	R.A. Tallent	W. J. Semioli
	J. W. Davidson	D.R. Ladner	B.T. Burns	R. E. Fronczak
	H. J. Laga	R.A. Tallent	J.J. Horney	W. P. Cunningham
	A. S. Uppal	B.T. Burns	W.J. Semioli	J. H. Smith
	T. E. Kuhn	J.J. Horney	D.W. Brookings	E. Bond
	D. R. Ladner	W.J. Semioli	W.P. Cunningham	D. L. Steele
	R. A. Tallent		J.H. Smith	M. C. Walbrun

	1986-1987	1987-1988	1988-1989	1989-1990
President	J. T. Kapp	D. J. Lewis	R. A. Tallent	B. T. Burns
Sr. Vice President	D. J. Lewis	R. A. Tallent	B. T Burns	J. J. Horney
Jr. Vice President	R. A. Tallent	B. T. Burns	J. J. Horney	M. C. Walbrun
Jr. Vice President	B. T. Burns	J. J. Horney	M. C. Walbrun	P. H. Saletnik
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	J. M. Williams	J. M. Williams	J. M. Williams
Directors	W. H. Nelson	M. C. Walbrun	C. E. Thompson	W. H. Nelson
	J. H. Smith	S. Lipkus	H. L. Davidson	T. J. Parker
	J. J. Horney	D. L. Steele	J. A. VanHuis	R. C. Karsten
	M. C. Walbrun	C. E. Thompson	W. H. Nelson	R. C. Carter
	E. Bond	H. L. Davidson	T. J. Parker	T. V. Dunn
	D. L. Steele	J. A. VanHuis	R. C. Karsten	M. L. Bradley
	C. E. Thompson	W. H. Nelson	S. Lipkus	D. G. DeBerg
	H. L. Davidson	T. J. Parker	T. V. Dunn	D. F. Sorgenfrei
	J. A. VanHuis	R. C. Karsten	M. L. Bradley	J. A. Lileikis

	1990-1991	1991-1992	1992-1993
President	J. J. Horney	M. C. Walbrun	P. H. Saletnik
Sr. Vice President	M. C. Walbrun	P. H. Saletnik	D. L. Steele
Jr. Vice President	P. H. Saletnik	D. L. Steele	J. A. Van Huis
Jr. Vice President	W. H. Nelson	J. A. Van Huis	M. L. Bradley
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	D. J. Lewis	D. J. Lewis
Directors	R. C. Carter	D. G. DeBerg	D. L. McCammon
	T. V. Dunn	D. F. Sorgenfrei	J. T. Creighton
	M. L. Bradley	J. A. Lileikis	J. G. Bradley
	D. G. DeBerg	D. L. McCammon	R. W. Carter
	D. F. Sorgenfrei	J. T. Creighton	C. W. Young
	J. A. Lileikis	J. G. Bradley	D. K. Franz
	D. L. McCammon	R. W. Carter	J. L. Hostler
	J. T. Creighton	C. W. Young	J. L. Neece

CONSTITUTION

(Revised September 18, 1990)

ARTICLE I

NAME

Section 1. This Association shall be known as the American Railway Bridge and Building Association.

ARTICLE II

OBJECT

Section 1. The object of this Association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway structures and fixed facilities by investigation, reports and discussions.

Section 2. The Association shall neither endorse nor recommend any particular devices, trademarks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussion unless the same have received the endorsement of the Association in regular session.

ARTICLE III

MEMBERSHIP

Section 1. The membership of this Association shall be divided into five classes: Members, Life members, Associate members, Honorary members and Junior members.

Section 2. A member shall be a person in the railway industry (except representatives of manufacturers and/or suppliers of equipment, material or labor services, or individuals who are subject to collective bargaining) engaged in engineering, construction and maintenance of railway structures and fixed facilities; a person in the employ of a public regulatory body; a professor of engineering or architecture; a technical editor; a materials expert; a consulting engineer, or an engineer employed by a consulting engineering firm, engaged in the engineering, construction and maintenance of railway-related facilities; an engineer employed by a technical service or research and development organization; or an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this Association. Any person desirous of becoming a member shall make application upon the form prescribed by the Executive Committee, setting forth the applicant's name, address and practical experience. The applicant shall be recommended by at least one member of the Association to whom they are personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the Executive Committee, a majority vote being necessary in either instance.

Section 3. To be eligible for a life membership, an individual must have belonged to the Association for at least 15 years and in general must have retired from active employment due to age or physical disability. A life member shall have all the privileges of previous membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2 of this Article.

Section 4. Associate members shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to cooperate with members in the study and development of improved practices in the construction and maintenance of railway structures and fixed facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2 of this Article, except that they shall be recommended by either a member or an associate member of the Association to whom they are personally known.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the majority vote of the members present at a regular meeting. They shall have all the rights of members except that of holding office and shall be exempt from the payment of dues.

Section 6. Any person in the Association membership whose conduct in any way diminishes the professionalism or prestige of the Association, or who shall refuse to comply with the rules of this Association, shall forfeit membership in the Association on a two-thirds vote of the Executive Committee.

Section 7. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 8. Only members shall hold office in this Association, and only members and qualified life members shall be entitled to vote in the election of officers.

Section 9. Junior members shall be persons engaged in academic study toward a career in those areas described in Section 2 of this Article, but not currently employed in those areas. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members in Section 2 of this Article, except that they need not be recommended by a member of the Association. The term of junior membership shall be limited to five years.

ARTICLE IV

OFFICERS

Section 1. The officers of the Association shall be a president, a senior vice president, two junior vice presidents, a treasurer and nine directors, who, with the most recent past president, shall constitute the Executive Committee.

Section 2. The past presidents of this Association, previous to the most recent past president, who continue to be members shall be privileged to attend all meetings of the Executive Committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the Executive Committee without delay.

ARTICLE V

EXECUTIVE COMMITTEE

Section 1. The Executive Committee shall manage the affairs of the Association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the Association, and make all necessary purchases and contracts required to conduct the general business of the Association, but shall not have the power to render the Association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the Association.

Section 2. Meetings of the Executive Committee may be called by a majority of the members of the committee, providing ten days' notice is given to the executive committee by mail.

Section 3. Five members of the Executive Committee, one of which shall be either the president or a vice president, shall constitute a quorum for the transaction of business.

ARTICLE VI

ELECTION OF OFFICERS AND SECRETARY AND TENURE OF OFFICE

Section 1. Except as otherwise provided, the officers shall be elected at the regular annual meeting of the Association and the election shall not be postponed except by a two-thirds vote of the members present at said annual meeting. The election shall be by vote, a majority of the votes cast being required for election. Any member of the Association not in arrears for dues shall be eligible for office, but the president shall not be eligible for re-election.

Section 2. The president, two junior vice presidents, and treasurer shall hold office for one year and the directors for three years; three directors being elected each year. The senior vice president shall hold office for one year and ascend to the office of president at the expiration of such service. All officers shall retain their office until their successors are elected and installed. A director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3. The term of office of the treasurer may be terminated at any time by two-thirds vote of Executive Committee. The compensation of the treasurer shall be fixed by a majority vote of the Executive Committee.

Section 4. The secretary shall be appointed by a majority vote of the Executive Committee and the term shall terminate with the appointment of successor. The Executive Committee shall have the power, by two-thirds vote, to remove the secretary and appoint a successor at any time. The salary of the secretary shall be decided by a majority vote of the Executive Committee.

Section 5. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the Executive Committee.

ARTICLE VII

MEMBERSHIP FEE AND DUES

Section 1. Every member, upon joining this Association, shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the Executive Committee.

Section 2. A person stricken from the list of members because of non-payment of dues upon written application may be reinstated as a member in the former class of membership without loss of privileges, either upon payment of all back dues (which must accompany applications) or at the discretion of the Executive Committee voting in the manner prescribed in Section 2 of Article III.

ARTICLE VIII

LOCAL SECTIONS

Section 1. Upon the application of ten or more members of the Association residing in the same geographical district, or having offices therein, the Executive Committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this Association as the section membership may adopt and the Executive Committee approve.

Section 2. The parent Association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

By-Laws

(Revised December 2, 1990)

Time of Meeting

1. The regular meeting of this Association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.

2. It shall be within the power of the Executive Committee to change the time of the meeting if it becomes apparent that it is for the best interests of the Association.

Place of Meeting

3. The place of holding the annual meeting shall be determined by the Executive Committee not less than twelve months prior to the date of the annual meeting.

Quorum

4. At the regular meeting of the Association, 15 or more members shall constitute a quorum.

Dues

5. The annual dues for the fiscal year ending August 31, and payable in advance, shall be as follows:

Members, $25.00; Associate Members, $25.00; Junior Members, $25.00

Duties of Officers

6. The president shall have general supervision over the affairs of the Association. He shall preside at all meetings of the Association and of the Executive Committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. The president shall render a detailed report at least three times during the year to the members of the Executive Committee, showing the financial condition of the Association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the Association.

7. The vice presidents, in order of seniority, shall preside at meetings in the absence of the president and discharge the duties of the president in case of a vacancy in his office. The senior vice president shall have the senior position of vice presidents.

8. The secretary shall keep a correct record of the proceedings of all meetings of this Association, and of all accounts, between this Association and its members, collect all moneys due the Association, and deposit the same in the name of the Association. The secretary shall pay all bills when properly certified and approved by the president or the treasurer, and make such reports as may be called for by the Executive Committee. The secretary shall sign all contracts or other written obligations of the Association which have been approved by the Executive Committee. The secretary shall also perform such other duties as the Association may required.

9. The treasurer shall have charge of the funds, check all deposits as made by the secretary, and invest all funds not needed for current expenses. The treasurer shall report at each annual meeting on the condition of the finances.

Nominating Committee

10. After each annual meeting the president shall appoint a committee consisting of five members. The most immediate past president shall act as chairperson. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual meeting in accordance with Article VI of the Constitution, said list to be read at the business session of said meeting. Nothing in this section shall be construed to prevent any member making further nominations provided that such nominations are received by the president in writing not less than thirty (30) days in advance of the first day of the annual meeting. Such nominations should be addressed to the president of the Association at its headquarters office.

Auditing Committee

11. Prior to each annual meeting the president shall appoint a committee of three members, not officers of the Association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

Orders of Business

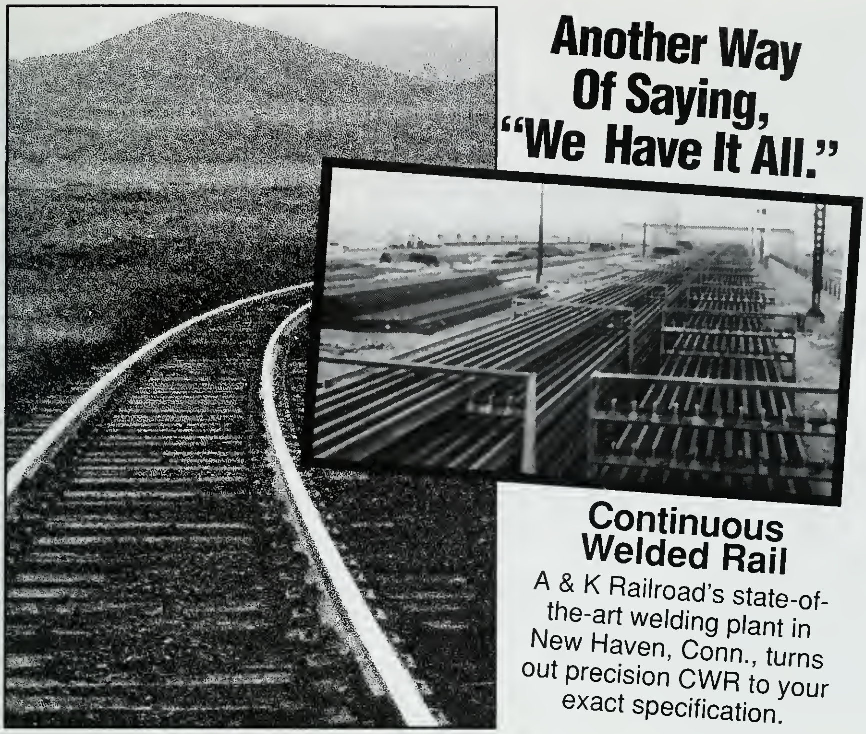
12. Call to order by president.
    - Opening prayer or invocation.
    - President's address
    - Reports of standing committees and presentation of papers
    - Election of officers
    - Business session
        - Report of secretary
        - Report of treasurer
        - Report of auditing committee
        - Report of necrology committee
        - Unfinished business
        - New business
    - Installation of officers
    - Adjournment

Decisions

13. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the Association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's Rules of Order.

Amendments

14. The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.



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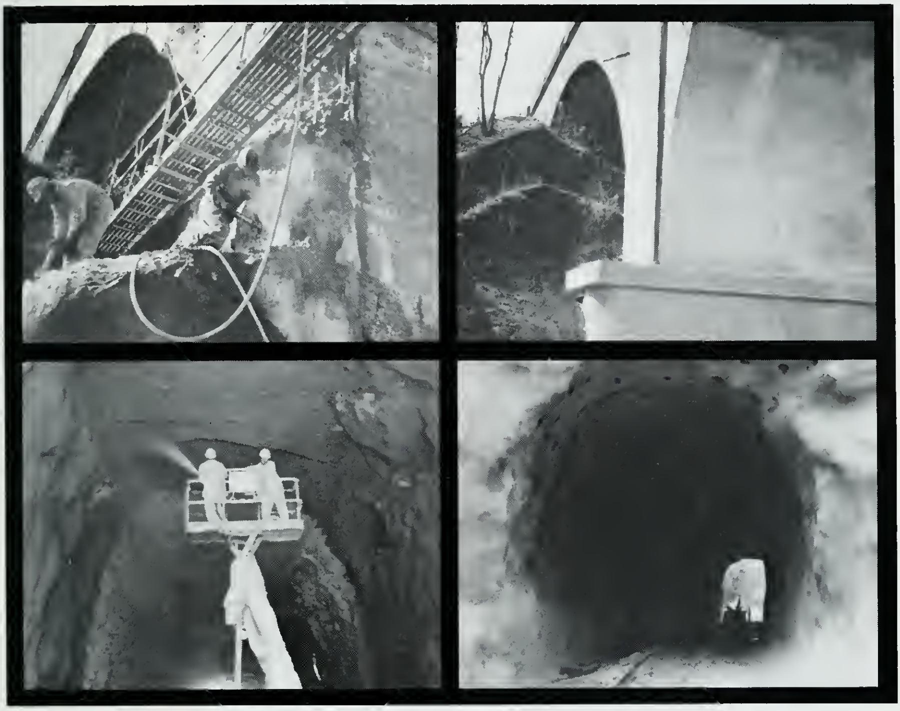

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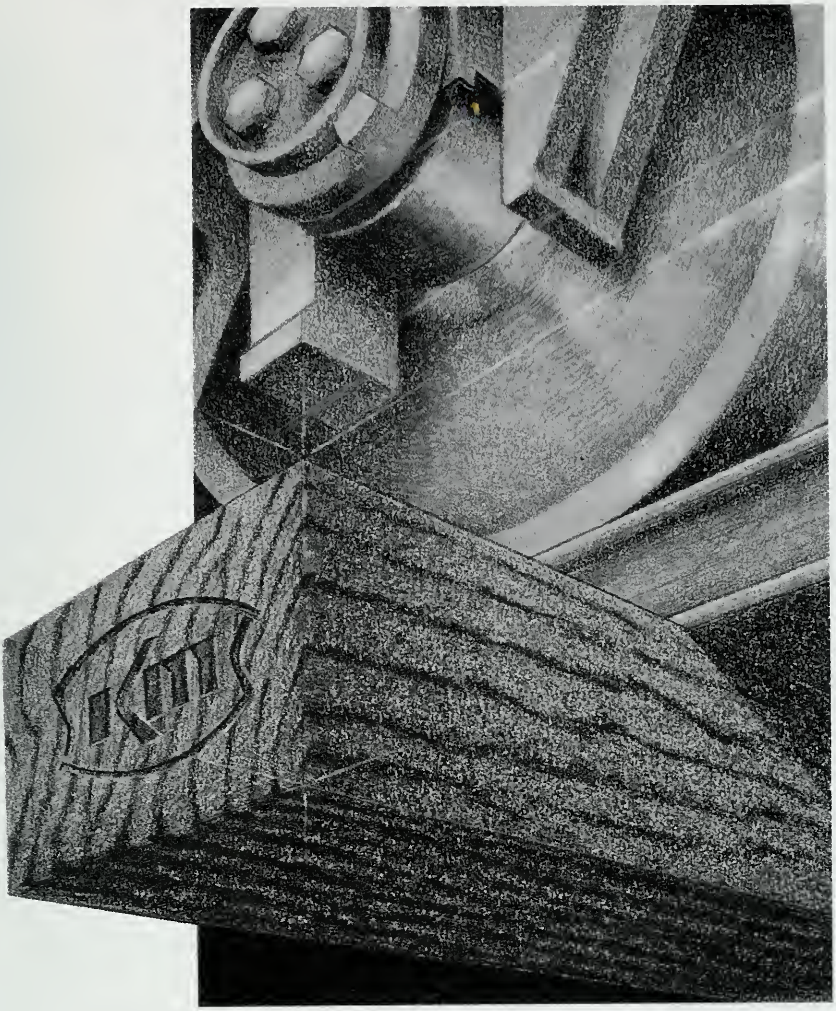

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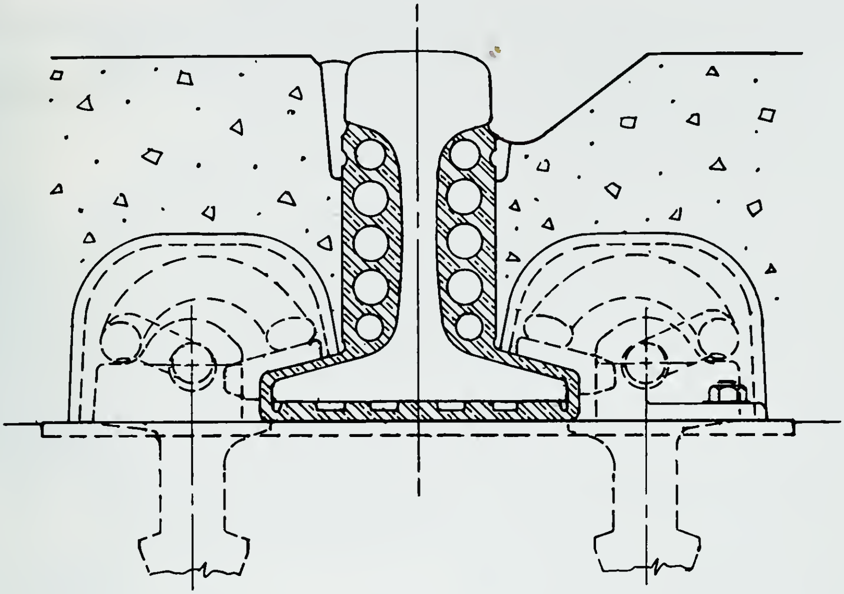

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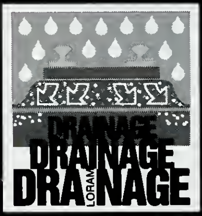

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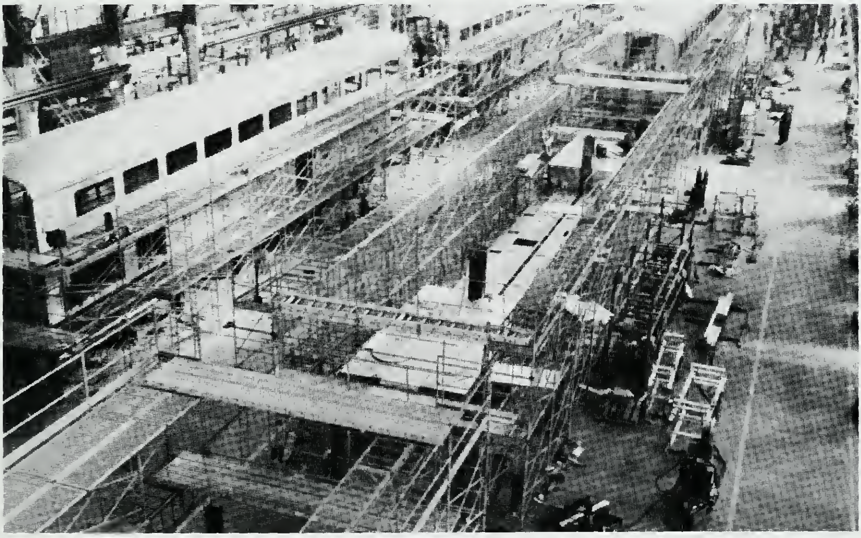

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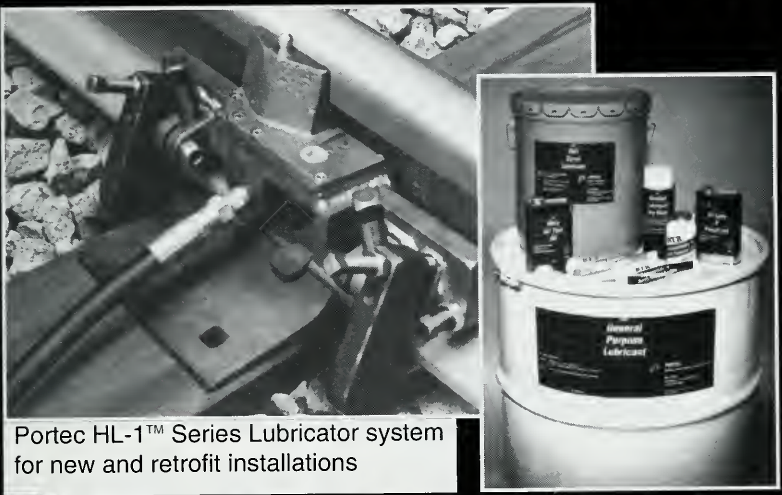

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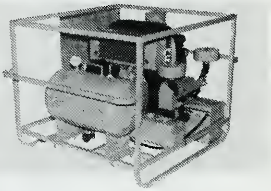

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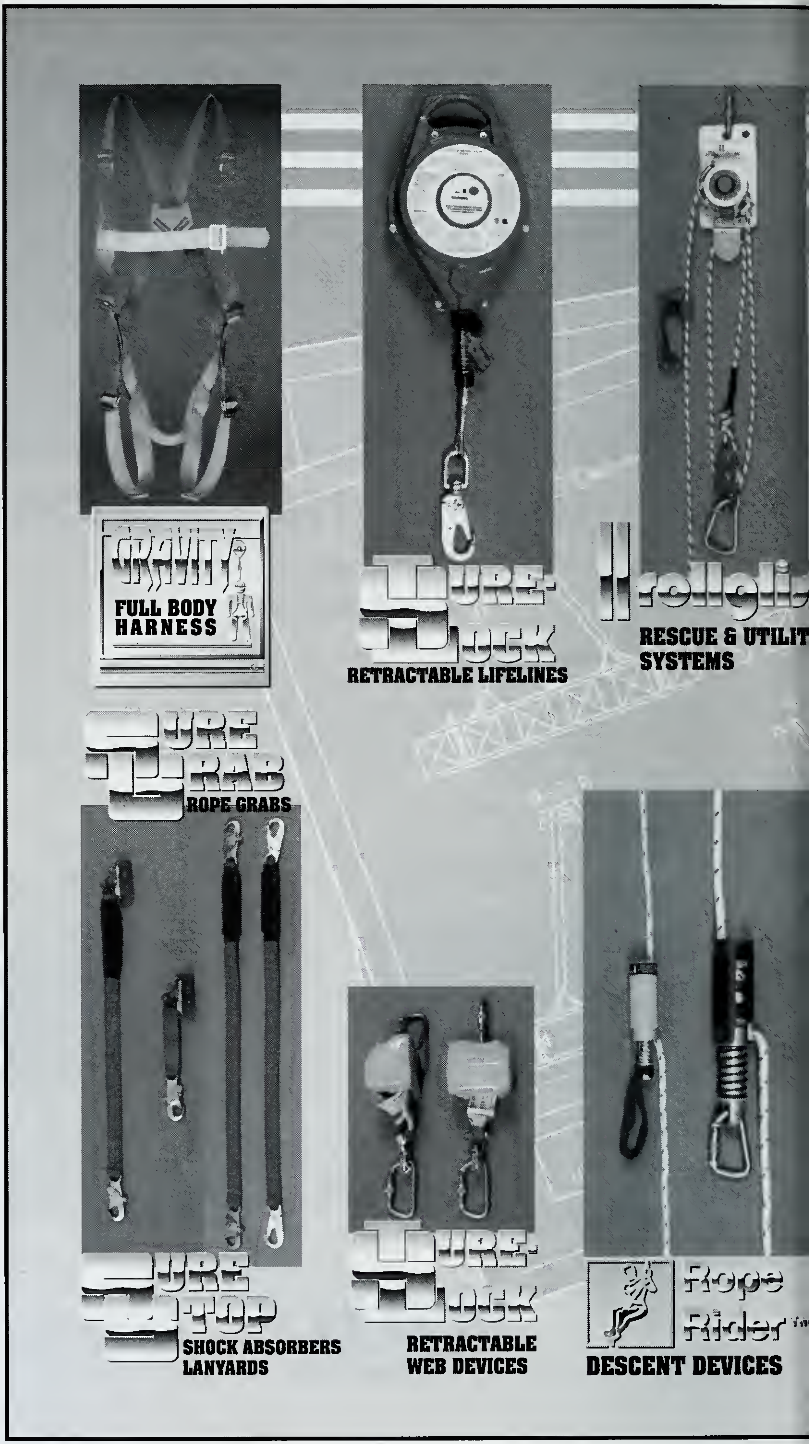
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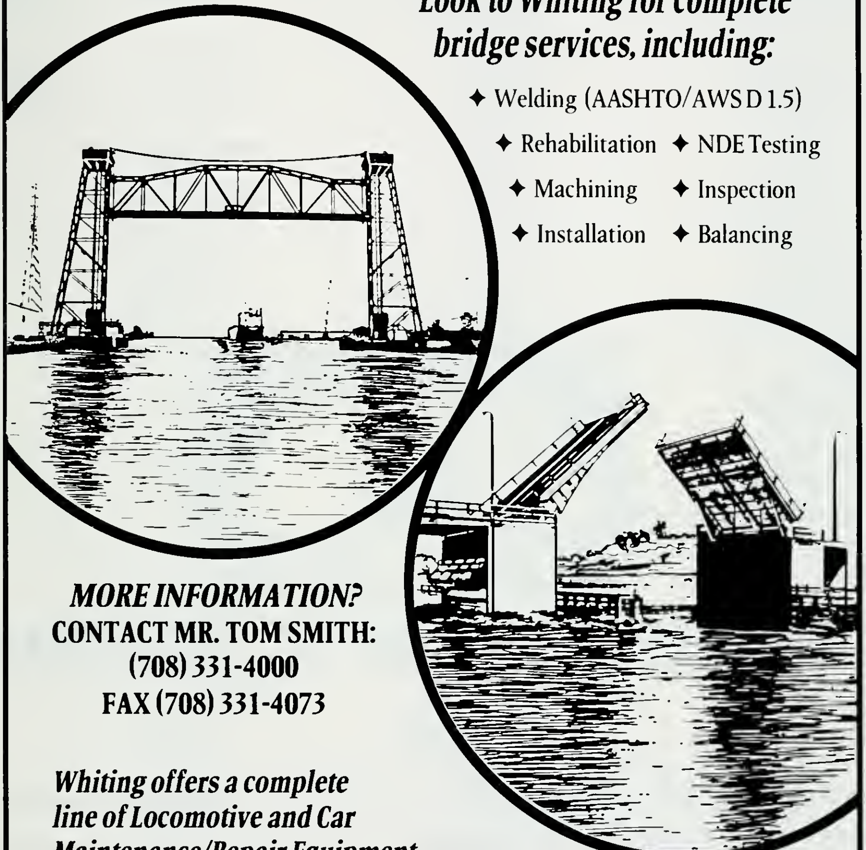

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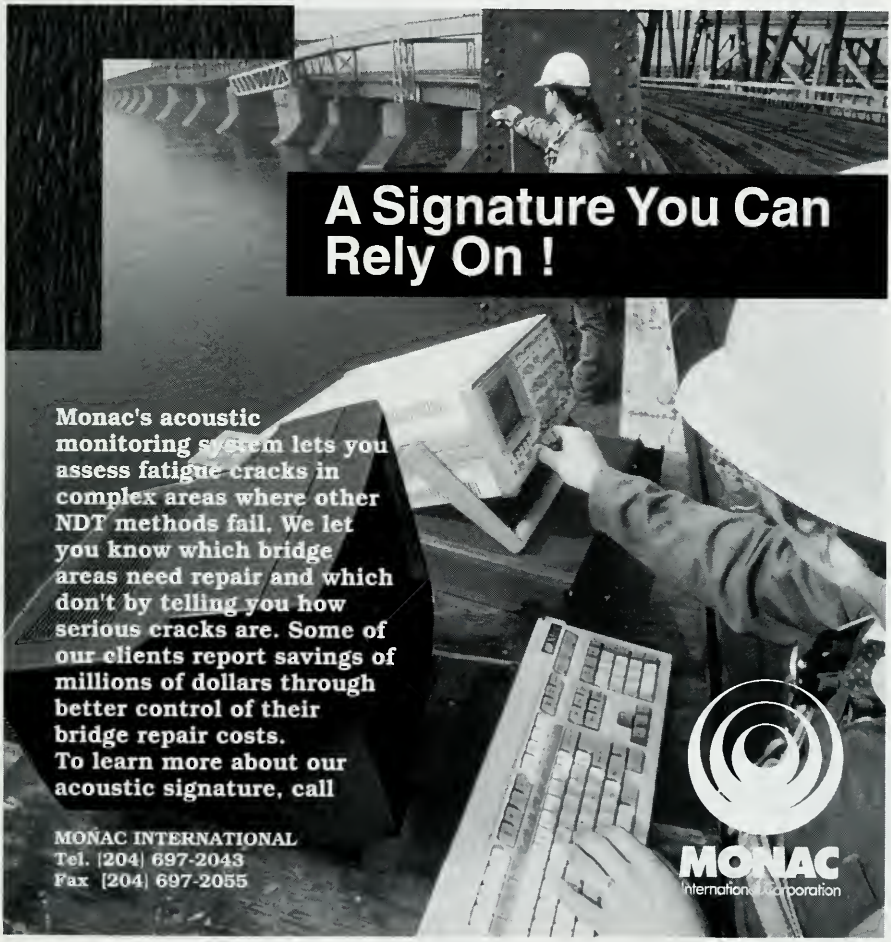

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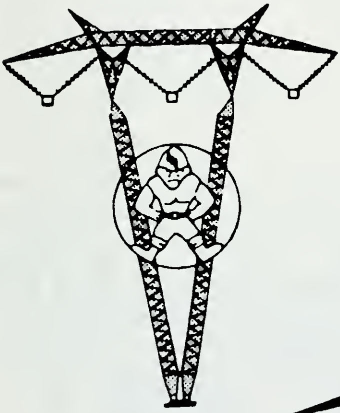

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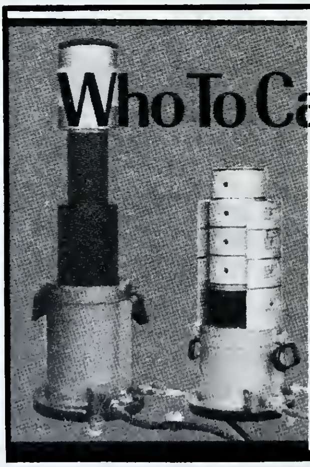

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The American Railway Bridge and Building Association is the only professional organization dedicated solely to the railway bridge and building field. The Association welcomes membership from qualified railroad employees above the rank of gang foreman; railroad officers, educators, railway editors, public officials, consulting engineers, and architects are all welcome to apply for membership.

The Association annually sponsors special reports on subjects of interest to the railroad industry. These reports, along with other special technical presentations, are featured at the Association's Annual Conference held each fall; every fourth year the REMSA railway engineering equipment show is held concurrently with the technical conference. The Association's committees are constantly working to achieve the latest and best knowledge on subjects of current interest to railroaders.

The Association gives every member the opportunity to develop his qualities of leadership by means of committee and Association work. Through committee work and discussions, members develop their knowledge and ability; second, through contact with a large number of people in the same line of endeavor, one has the opportunity to acquire new ideas which can be put to work for both the individual and his company.

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I hereby make application for membership in the American Railway Bridge and Building Association. Enclosed is my first year's dues.

Name ________________________________ Birth Date ________________

Position ____

Company ____

Address ____

City, State, Zip ____________________________ Phone ________________

Railroad Experience (departments, length of service, etc.) ____________________

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References: (Provide one indicating company affiliation and address.)

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I hereby agree, if admitted, that in all matters pertaining to my connection with this Association and my membership in the same, I will be governed by its Constitution and By-Laws, and will personally endeavor to advance the objects and interests of the Association to the best of my ability.

Signed ____

(Extract from Constitution)

Article III - Membership

Sec. 1. The membership of this association shall be divided into five classes, viz; Members, junior members, life members, associate members and honorary members.

Sec. 2. A member shall be a person in the railway industry (except representatives of manufacturers and/or suppliers of equipment, material or labor services , or individuals who are subject to collective bargaining) engaged in engineering, construction and maintenance of railway structures and fixed facilities; a person in the employ of a public regulatory body; a professor of engineering or architecture; a technical editor; a materials expert; a consulting engineer, or an engineer employed by a consulting engineering firm, engaged in the engineering, construction and maintenance of railway-related facilities; an engineer employed by a technical service or research and development organization; or an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this Association. Any person desirous of becoming a member shall make application upon the form prescribed by the Executive Committee, setting forth the applicant's name, address and practical experience. The applicant shall be recommended by at least one member of the Association to whom they are personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the Executive Committee, a majority vote being necessary in either instance.

Sec. 4. Associate members shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to cooperate with members in the study and development of improved practices in the construction and maintenance of railway structures and fixed facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Sec. 2 of this Article, except that they shall be recommended by either a member or an associate member of the Association to whom they are personally known.